

THE
PHILOSOPHICAL
TRANSACTIONS,
AND
COLLECTIONS,

To the End of the Year 1700.

ABRIDG'D

AND

Dispos'd under GENERAL HEADS.

VOL. II.

Containing all the
Physiological Papers.

By JOHN LOWTHORP, M. A.
and F. R. S.

LONDON:

Printed for J. Knapton, R. Knaplock, R. Wilkin, J. and B. Sprint,
D. Midwinter, R. Robinson, W. Taylor, W. and J. Innys, and
J. Osborn. MDCCXXII.

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Dispos'd under GENERAL HEADS

VOL. II.

Physiology Papers

By JOHN E. THOMAS, M.D.
and T. R. S.

LONDON:

Printed for J. Knapp, R. Knaplock, R. Waller, J. and R. Waller,
D. Midwinter, R. Robinson, W. Taylor, W. and J. Taylor, and
J. O. Lewis, MDCCCXII.

TO HIS GRACE
The DUKE
OF
ORMOND,
LORD LIEUTENANT
OF
IRELAND, &c.

THESE
Physiological Papers
ABRIDG'D
AND

Dispos'd under GENERAL HEADS,

Are with all Possible

Humility and Gratitude,

Dedicated by

John Lowthorp.

John Lambton.

Dedicated by

Humility and Gratitude

Are with all possible

Dispos'd under GENERAL HEADS

AND

A B R I D G E

Physiolog. Papers

THESE

I R E L A N D

OF

LORD TREASURER

O R M O N D

OF

The D U K E

TO HIS GRACE



THE
Physiological Papers,

PUBLISHED and DISPERSED
IN THE
PHILOSOPHICAL
Transactions and Collections,
ABRIDGED;
AND
Disposed under GENERAL HEADS.



CHAP. I.
PHYSIOLOGY.

Meteorology. Pneumatics.

I. **T**HE *Academie des Sciences* has lately received great Splendour by the Regulations, Encouragement, and Orders, M. L'Abbe Bignon has obtained to it from the King. That Academy is now composed of 10 *Honorary Academicians*, which are chosen learned and eminent Gentlemen; of 8 *Strangers Associates*, which are distinguished by their Learning; 20 *Pensioners* Fellows, 20 *Eleves*, and 20 *French Associates*, who are divided into 6 Classes, viz. Geometricians, Astronomers, Mechanicians, Anatomists, Chymists, and Botanists.

Out of the *Honorary Academicians*, two are elected every Year, one for President, the other for Vice-President; only 20 *Pensioners* have every Year 1500 *French Livres*; and after the Death of one *Pensioner*, the Academy will propose to the King 3 Persons *Associates*, or *Eleves*, or sometimes others; and his Majesty will call one of the 3 for *Pensioner*.

*The Cause of
the present
languid State
of Philoso-
phy by M.
Leibnitz.
n. 255. p.
273.*

II. 1. Nescio quomodo remissius nunc tractantur Studia altiora, cum ta-
men nunquam, post tot aditus apertos, facilius potuerint tractari. Sed puto
infelicia tempora intercessisse, dum bella curas Hominum alio vertere, ita
pauci admodum juvenes in pristinae Gloriæ spem succrescunt. Etiam natura
quam paucos nunc Observatores diligentes habet. Utinam, ut Gallica Scien-
tiarum Academia nuper à Rege suo restituta est, etiam vestrae Regiæ Socie-
tati novus Calor infunderetur.

*By Dr. J.
Wallis. ib.
p. 281.*

2. Quod tu quereris, remissius nunc tractari altiora studia; & pauciores
esse naturæ Observatores diligentes; quadantenus verum esse non diffiteor.
Sed mirandum non est, (ut res alias, sic) hominum Studia, suas habere vi-
cissitudines. Præsenti Seculo (quod jam ad finem vergit) Eruditionem, in
omni rerum genere, insignes (& quidem insperatos) processus obtinuisse,
certum est; in re Physica, Medica, Chymica, Anatomica, Botanica, Ma-
thematica, Geometrica, Analytica, Astronomica, Geographica, Nautica, Me-
chanica, ipsaque (quod minus lætor) Bellica. Et quidem longe majores
quam per multa retro secula obtinuerat: Quippe quibus vix aliud sibi propo-
suisse videntur Homines, quam ut intelligere videantur quæ ab Euclide, Ari-
stotele, cæterisque ex antiquis jam olim fuerint tradita; de Progressu porro
faciendo haud solliciti; quasi Scientiarum Metas posuerint illi, quas transcen-
dere sit nefas. Cum vero ausi sint aliqui (& quidem pauci) ultra prospicere;
facti sunt aliis animi, late patentem campum ingredi: Et res novas aggredi,
novus Ardor, novus Impetus impulit; nec infelicitè. Sed, postquam hæc
desiit esse res nova; hic novus Ardor defervuit. Mortui sunt ex sedulis in-
dagatoribus non pauci, alii morituri: juvenesque non accendebat (ut antea)
rerum Novitas.

Sed & ipsa materia erat magna ex parte exhausta; ut non tam messis jam
speranda sit, quam Spicilegium. Et quidem, jam fessis & fatigatis permit-
tendum videatur, ut quadantenus quiescant: atque hinc factum (pro variabi-
li natura hominum,) quod severiora studia negligantur, fierique forte potest,
(quod tamen ominari nollem) ut præsentis seculi diligentia succedat desidia
sequentis.

Oportet tu, (& quidem ego pariter) ut, sicut Gallorum Academia Scientia-
rum jam videatur restituta, sic nostræ Societati Regiæ novus Calor infunde-
retur. Atque hoc ipsum jam modo monui tuis Verbis. Sed & ipsi (quod
tibi non displicebit) reapse me monentem prævenerant; qui jam nuper sibi
novas Leges posuerunt, varias hujusmodi Inquisitiones viritim promovendi.
Sed & inter Gallorum illam Academiam, nostramque Societatem, hoc inter-
est Discriminis: Fruuntur illi sumptibus Regis, suisque gaudent singulatim
Salaris. Nostri suis Sumptibus agunt omnia.

*A deep Cave
in the Ob-
servatory at
Paris; by
M. . . . n.
74. p. 2217.*

III. In the Royal Observatory at *Paris*, there is, besides many other Rooms
fit for philosophical Uses and Purposes, a very deep Cave, having 170 Steps
of Descent; wherein many sorts of Experiments are intended to be made,
being of that Nature, that they require to be remote from the *Sun-beams* and
the open Air; such as are *Thermometrical* ones, and such as concern *Refrige-
rations, Coagulations, Indurations, and Conservations of Bodies, &c.*

*Barometers,
and Observa-
tions made
with them.
n. 9. p. 153.*

IV. 1. The Barometer or Baroscope was first made publick by that no-
ble Searcher of Nature, Mr. *Boyle*, and employed by him and others, to de-
tect

test all the minute Variations in the Pressure and Weight of Air. With this Instrument he made divers Observations in the Year 1659, and 1660, before any others were publick, or by him so much as heard of.

2. Dr. J. Beal is so much pleased with the Discovery already made by the help of this Instrument, that he thinks it to be one of the most wonderful that ever was in the World. For (saith he) who could ever expect, that we Men should find an Art to weigh all the Air that hangs over our Heads, in all the Changes of it, and as it were, to weigh, and to distinguish by Weight, the Winds and the Clouds? Or, who did believe, that by palpable Evidence, we should be able to prove, the serenest Air to be the most heavy; and the thickest Air, and when darkest Clouds hang nearest to us, ready to dissolve or dropping, then to be lightest?

By Dr. J.
Beal. ib. p.
134.

1. My Wheel Barometer I could never fill so exactly with Mercury, as to exclude all Air; and therefore I trust more to a Mercurial Cane, and take all my Notes from it. This Cane is but 35 Inches long, of a very slender Cavity, and thick Glass.

2. In all my Observations from May 28, 1664, to this present (December 9, 1665,) the Quick-silver never ascended but very little above 30 $\frac{1}{2}$ Inches.

3. It ascended very seldom so high, (viz. to 30 $\frac{1}{2}$ Inches) chiefly in December 13, 1664, the Weather being fickle, fair Evening.

4. I find by my Calender of June 22, 1664, at 5 in the Morning, in a time of long settled fair Weather, that the Mercury had ascended about half an Inch higher than 30. But I fear some Mistake, because I then took no Impression of Wonder at it; yet for 3 or 4 Days, at that time it continued high, in well settled, fair and warm Weather; most part above 30 Inches. So that I may note the Mercury to rise as high in the hottest Summer, as in the coldest Winter Weather.

5. Yet surely I have noted it to ascend a little higher for the Coldness of the Weather; and very frequently, both in Winter and Summer, to be higher in the cold Mornings and Evenings, than in the warmer Mid-day.

6. Generally in settled and fair Weather, both of Winter and Summer, the Mercury is higher than a little before, or after, or in rainy Weather.

7. Again, generally it descended lower after Rain, than it was before Rain.

8. Generally also it falls in great Winds; and somewhat it seemed to sink, when I opened a wide Door to it, to let in stormy Winds; yet I have found it to continue very high in a long stormy Wind of three or four Days.

9. Again, generally it is higher in an East and North Wind (*ceteris paribus*) than in a South and West Wind.

10. I tryed several times, by strong Fumes, and thick Smoaks, to alter the Air in my Closet; but I cannot affirm, that the Mercury yielded any more than might be expected from some Increase of Heat. Such as have exact Wheel Barometers, may try whether Odors or Fumes do alleviate the Air.

11. I have not in all this time found the extreamest Changes of the Quick-silver to amount to more than to $2\frac{1}{2}$, or to $2\frac{1}{2}$ Inches at most.

12. Very often I have found great Changes in the Air, without any perceptible Change in the Barometer; as in the dewy Nights, when the Moisture descends in a great Quantity, and the Thickness sometimes seems to hide the Stars from us. In the Days foregoing and following, the Vapours have been drawn up so invisibly, that the Air and Sky seemed very clear all Day long. This I account a great Change between ascending and descending Dews and Vapours (which import Levity and Weight) and between thick Air and clear Air; which Changes do sometimes continue, in the alternative Course of Day and Night, for a Week or Fortnight together; and yet the Baroscope holding the same.

13. Sometimes (I say not often) the Baroscope yields not to other very great Changes of the Air. As lately (*Dec. 18.*) an extraordinary bright and clear Day; and the next following quite darkned, some Rain and Snow falling, but the Mercury the same: So on high Winds and Calms the same.

14. I do conceive, that such as do converse much *sub dio*, and walk much abroad, may find many Particulars much more exactly than I, who have no leisure for it, can undertake. To instance in one of many, *Dec. 16, 1665*, was a clear cold Day, very sharp and strong East Wind, the Mercury very near 30 Inches high; about 3 in the Afternoon I saw a large black Cloud drawing near us from the East and South-east, with the East Wind. The Mercury changed not that Day, nor the Day following; the Stars and most of the Sky were very bright and clear till nine of the Clock; and then suddenly all the Sky was darken'd, yet no Change of Weather happen'd. *Dec.*

17. the Frost held, and 'twas a clear Day, till about two of the Clock in the Afternoon; and then many thick Clouds appeared low in the West; yet no Change of the Weather here; the Wind, Frost, and Quick-silver, the same. *Dec. 18.* the Mercury fell almost $\frac{1}{2}$ of an Inch, and the Sky and Air so clear and bright, and cold, with an East Wind, that I wonder'd what could cause the Mercury to descend. I expected it should have ascended, as usually it does in such clear Skies. Casually I sent my Servant abroad, and he discovered the remote Hills, about 20 Miles off, covered with Snow. This seemed to manifest that the Air, being discharged of the Clouds by Snow, became lighter.

15. I have seldom seen the Change to be very great at any one time, so that I once wonder'd to see, that in one Day it subsided about $\frac{1}{4}$ of an Inch.

16. *Jan. 13, 1665*, the Mercury stood (as it did also the Day before) a quarter above 30 Inches; yet both Days very dark and cloudy, sometimes very thick and misty Air, which seldom falls out. For, for the most part, I see it higher in clearest settled Weather, than in such cloudy and misty Fogs. This thick Air and Darkness hath lasted above a Week; lately more cold, and East and North-east Wind.

n. 10. p. 163.

17. I have not yet found any such infallible Prognostick of these Changes of

of Weather, which do follow a long Serenity, or settled Weather. And perchance in brighter Climates it may be constantly infallible. I have store of Hygrosopes of divers kinds; and I do remark them, and the Swearings of Marble, and as many other famed Prognosticks as I can hear of; but can find nothing so nearly indicative of the Change of Weather, as this Balance. And the open Weather-glass is known to signify nothing at certainty, having a double Obedience to two Masters; sometimes to the Weight of the Air, sometimes to Heat, as the Service is commanded.

18. In *Jan.* 166 $\frac{1}{2}$, for many Days it continued very dark, so that all Men expected daily great Rain; and though sometimes thick Mists arose, and some small Rain fell, yet the Quick-silver held at a great height; which did indicate to me there could then be no great Change of Weather, and I was not disappointed.

19. If the Mercury ascends to a good height after the fall of Rain (as sometimes, but less often it does) then I look for a settled Serenity; but if it proceeds after Rain in a descending Motion, then I expect a continuance of broken and showry Weather.

20. That we find the Weather and our Bodies more chill, cold and drooping, when the Mercury is lowest, and the Air lightest; besides other Causes, I guess that as Air is to us the Breath of Life, as Water is to Fishes; so when we are deprived of the usual Measure of this our Food, 'tis the same to us as when the Water is drawn ebb from the Fishes.

21. The lowest Descent of the Mercury in all the time since I have observed it, was *Oct.* 26, 1665, in the Evening, when it was very near at 27 $\frac{1}{2}$ Inches. Which I find thus circumstanced with the Weather in my Notes.

Oct. 25. Morning; Mercury at 28 $\frac{1}{2}$ Inches, great Storms and much Rain.

Oct. 26. Morning; Mercury at 28, Winds quiet, thick dark Clouds.

Oct. 26. Evening; Mercury at 27 $\frac{1}{2}$, that Day, and some Days following, the Weather was variable, frequent Rain, and as you see, the Mercury lower than usual.

22. Over the place where this mercurial Cane stands, I have set a Wind-Vane, with purpose of Exactness, of a Streamer in Brass so large, and pointing to a Board indented in the Margin, that I can at a sure Level upon the Vane, take every of the 32 Points of the Wind, half Points and quarter Points, at a good distance. It were good to have an Index of Winds, that discovered as well their Ascent and Descent, as their side Coastings.

23. By Change of Weather and Wind, the Mercury sunk since *March* 12 n. 11. p. 185. more than an Inch; and this last Night of *March* 18, by Rain and South Wind, 'tis sunk half an Inch.

24. I found the Quick-silver, *Dec.* 16, 1669, higher than I dare po- n. 55. p. 1118. sitively affirm that it was ever since I had it in my Custody, viz. since *May* 28, 1664. It was compleatly and apparently above half an Inch more than 30 Inches high. It continued the 14th, and some part of the 15th, at about that height; sometimes manifestly higher to an eighth or tenth part of an Inch. For this Baroscope I have two Glass Canes in one Vessel of stagnant

stagnant Quick-silver; and both of them agreed in this Indication. The Weather was at first discovery very bright and clear, a gentle Frost, by the Sun's Heat melting. The Air was very silent, no Wind stirring, and the curious Wind-vane noting, that the Wind was directly in the East all the first Day, viz. Dec. 13. On Dec. 14. the Wind had a short swing from the North-west, and hastened again towards the East, yet so as to be North-east. During this Agitation, or Change of Winds, the Mercury descended a little; and after, upon the resettling of the Wind, the Mercury ascended a little higher than it had been the Day before.

My House and Study where I keep this Baroscope, is on the side of an Hill; on the higher side of this Country, as I guess near a level with the Head of a River; which River running slowly, and falling into the *Severn* Sea about 20 or 30 Miles westward of *Bristol*, we cannot be very much above the Level of the Sea. My Thermoscope standing close by my said Barometer, was at the just height of ordinary dissolving Weather. In the following Days it was colder. Whether the late Summer Drought, or what else might incline this Winter Air to have more than ordinary Weight, or a stronger Spring, I must refer to the Consideration of the more skilful.

By Dr. J.
Wallis.

n. 10. p. 169.

3. In my Baroscope I never found the Quick-silver higher than 30 Inches, nor lower than 28, (at least scarce discernibly, not $\frac{1}{16}$ of an Inch higher than that, or lower than this:) which I mention, not only to shew the Limits within which I have observed mine to keep, viz. full 2 Inches, but likewise as an Estimate of the Clearness of the Quick-silver from Air. For though my Quick-silver was with good care cleansed from the Air, yet I find that which Mr. Boyle useth, much better: For, comparing his with mine at the same times, and both in *Oxford*, at no great distance; I find his Quick-silver to stand always somewhat higher than mine (sometimes near a quarter of an Inch;) which I know not how to give a more probable account of, than that my Quick-silver is either heavier than his, or else that his is better cleansed from the Air; (unless possibly, the difference of the Bore; or other Circumstances of the Tube, may cause the alteration; mine being a taller Tube, and a bigger Bore than his.) And upon like Reason, as his stands higher than mine; so another, less cleansed from Air, may at the same time be considerably lower, and consequently under 28 Inches at the lowest.

In thick foggy Weather, I find my Quick-silver to rise, which I ascribe to the Heaviness of the Vapours in the Air.

In Sun-shiny Weather it riseth also (and commonly the clearer, the more;) which, I think, may be imputed partly to the Vapours raised by the Sun, and making the Air heavier; and partly to the Heat, increasing the elastick or springy Power of the Air. Which latter I the rather add, because I have sometimes observed in Sun-shiny Weather, when there have come Clouds for some considerable time (suppose an Hour or two) the Quick-silver has fallen; and then upon the Sun's breaking out again, it has risen as before.

In rainy Weather, it useth to fall (of which the Reason is obvious, be-

cause the Air is lighten'd, by so much as falls) in showry Weather likewise, but not so much as in Rain. And sometimes I have observed it, upon a Hoar-frost, falling in the Night.

For windy Weather, I find it generally to fall; and that more universally, and more discernibly, than upon Rain: (which I attribute to the Wind's moving the Air collaterally, and thereby not suffering it to press so much directly downwards; the like of which we see in swimming, &c.) And I have never found it lower than in high Winds.

I have divers times, upon discerning my Quick-silver to fall without any visible Cause at home, looked abroad; and found (by the appearance of broken Clouds, or otherwise) that it had rained not far off, though not with us: Whereupon the Air being then lighten'd, our heavier Air (where it rained not) may have in part discharged itself on that lighter.

Whereas I formerly observed, that in hot Weather, the Quick-silver ^{n. 55. p. 1116.} in the Baroscope did use to rise observably, especially in Sunshine and the Heat of the Day; I now find (having kept the same Barometer for the space of 5 Years unaltered) the Case, for these two Years last past, to be somewhat otherwise: And that in hot Sun-shiny Weather the Quick-silver doth rather subside a little; and in extreme cold and frosty Weather it riseth. I judge the Cause of these contrary Observations to be this, *viz.* That the Quick-silver, at its first putting into the Tube or Baroscope, was not so perfectly cleansed from Air, but that some small quantity of it did remain undiscerned in the Quick-silver: Which latent Particles of Air, though so small as not to be at all discernible to the Eye by Bubbles, yet by the external Heat (adding new Strength, as it useth to do, to its elastick or springy Power) were so much expanded as to make the Quick-silver specifically lighter, and consequently to rise somewhat higher, and upon the Recess of the external Heat, the Spring of the Air again slackning, suffered the Quick-silver to be again contracted into its former lesser Dimensions, and so to become heavier, and not to rise so high as before, when it was hotter. But now the Quick-silver having continued in the Tube for five Years and upwards, hath by its own Weight cleansed itself better from that little Air that was in it; and that Air, freed from its Intanglement with the Quick-silver, being got up into the void part of the Tube above the Quick-silver, doth act contrarywise; that is, when it is by Heat (upon the strengthening of its Spring) expanded, it presseth downward upon the Quick-silver, and doth a little depress it; and on the contrary, when by Frost or very cold Weather this Air (by the Abatement of its Spring) is contracted, the Quick-silver, freed from that Pressure, riseth a little. But the rising and sinking upon this account, (as well that formerly, when the Air was in the Quick-silver, as that now, when it is gotten above it) is not very considerable; hardly exceeding the 12th part of an Inch.

I shall add another Accident which I lately took notice of. I observed in the late hard Frost, that a little drop of Water (which was at first made use of for the cleansing of the Quick-silver from the Air, and which hath ever since remained on the top of the Quick-silver within the Tube, was
frozen.

frozen fast to the Glas. Whereupon I did a little shake the Tube by moving it up and down, so as to make the Quick-silver undulate and strike against it. The noise upon these Strokes was not such a dull noise, as Quick-silver or other Liquids use to make in the open Air, by dashing against Glas or Ice, or other such hard Bodies; but such a hard smart noise, as hard Metals use to make by knocking one against the other; or, as if this Ice had been so knocked by a solid piece of Iron, or other Metal of such a bigness. Which difference of noise from what would have been in the open Air, (where the intermediate Air must first have been beat away, before the Quick-silver could strike the Ice, and thereby the Stroke of the liquid Body obtunded or broken,) I attribute to that voidness of Air, which was between the Ice and the distant Quick-silver.

Jan. 7. 16⁶², the Baroscope was at 29, but for some Days before about 28 $\frac{1}{2}$, (the Weather having been windy and rainy;) and so it was in the Frost about Dec. 25, but then continued to rise till about Jan. 2, to 29 $\frac{1}{2}$, but had been Dec. 13. at 30 $\frac{1}{2}$, which is the highest I have ever known it in my Baroscope; 27 $\frac{1}{2}$ being the lowest, that I have ever observed it in (Oct. 26, 1665) the most usual height being about 29, or somewhat higher.

By Mr. Boyle
n. II. p. 121.

4. It will be very convenient that Observers give notice of the Situation of the place where their Barometers stand, not only because it will assist Men to judge whether the Instruments were duly perfected, but principally because, that though the Baroscope be good (nay because it is so) the Observations will much disagree, even when the Atmosphere is in the same state, as to weight, if one of the Instruments stand in a considerably higher part of the Country than the other.

To confirm the foregoing Admonition, I must now inform you, that having in these parts two Lodgings, the one at Oxford, which you know stands in a bottom by the Thames side, and the other at a place 4 Miles thence, seated upon a moderate Hill, I found by comparing two Baroscopes that I made, the one at Oxford, the other at Stanton St. Johns, that, though the former be very good, and hath been noted for such, during some Years, and the latter was very carefully fill'd; yet by reason, that in the higher place the incumbent part of the Atmosphere must be lighter than in the lower, there is almost always between two and three eighths of an Inch difference betwixt them: And having sometimes order'd my Servants to take notice of the Disparity, and divers times carefully observed it my self, when I passed to and fro between Oxford and Stanton, I generally found that the Oxford Barometer and the other did, as it were by common consent, rise and fall together so, as that in the former the Mercury was usually $\frac{1}{4}$ higher than in the latter. Which Observations may teach us, that the subterraneous Steams which ascend into the Air, or the other Causes of the varying weight of the Atmosphere, do many times, and at least in some places, uniformly enough affect the Air to a greater height, than, till I had made this Tryal, I durst conclude.

But as most of the barometrical Observations are subject to Exception, so I found the formerly mentioned to be. For (to omit lesser Variations)
riding

riding one Evening from Oxford to Stanton, and having before I took Horse look'd on the Baroscope in the former of these two places, I was somewhat surprized, to find at my coming to the latter, that in places no farther distant, and notwithstanding the shortness of the time (which was but an Hour and a Half, if so much) the Barometer at Stanton was short of its usual distance from the other near a quarter of an Inch, though, the Weather being fair and calm, there appear'd nothing of manifest change in the Air, to which I could ascribe so great a variation; and tho' also since that time the Mercury in the two Instruments hath, for the most part, proceeded to rise and fall as before.

The Quick-silver has been of late for the most part so high, as to invite me to take notice of it: And about March 12, 166 $\frac{1}{2}$ at Oxford the Quick-silver was higher than, for ought I know, has been yet observed in England, viz. about $\frac{1}{10}$ above 30 Inches; but upon the first considerable Showers that have interrupted our long Drought, as I foretold divers Hours before that the Quick-silver would be very low, (a blustering wind concurring with the Rain) so I found it at Stanton to fall $\frac{1}{4}$ beneath 29 Inches.

It is difficult enough to settle any general Rule about the rising and falling of the Quick-silver; yet in these parts one of those that seem to hold oftenest is, that when high Winds blow the Mercury is the lower; and yet that it self does sometimes fail.

5. At my first Arrival I fixt my Weather Glass, and found the *Argentum Vivum* to ascend 29 inches, and in a Tornado 29 $\frac{1}{10}$. But a stranger by Accident broke the Cane, so that I could make no further Tryal.

6. When my Barometer was first set up, the Mercury stood one Degree below Changeable; I diligently observed it every Day, and found that in the Mornings before the Sun arose it would be there; and as the Heat increased with the Day, it sunk to within one Degree above Rain; there it continued several Days, and never altered above 3 Degrees, tho' sometimes fair, sometimes Rain, and sometimes cloudy; and one Morning leaving open my Window, and the Sun having South Declination, it shone in on the visible Part of the Tube, and in half an Hour it sunk 3 Degrees; (which I never observed it to do with heat in England) I presently shut the Window, and in one Hour it arose again to within one Degree of Changeable; after it had kept this Course in several Weathers, for 6 Weeks together, I began to doubt if it were well adjusted, and therefore took it down, new filled the Tube, turned it 3 or 4 times up and down, to let out the Air, and put it up with great Care, and ever since it continues the same, never by one degree to Changeable, nor down by one degree to Rain; so that the whole Progress of the Mercury is but $\frac{3}{10}$ of an inch.

7. March 3. 168 $\frac{6}{7}$ in the Evening, we had very much Thunder, and that and the next Day the Mercury in the Barometer was much lower than ever I observed it, viz. but $\frac{4}{10}$ above 28 inches.

8. I have found by a whole Mopth's Observations, Mr. Flamsteed was pleased to send me, the Mercury still rose and fell both at London and here exactly at the same time; I always found it rather more than $\frac{3}{10}$ of an inch

At Cabo-Cors in Guinea; by Mr. Heathcot, n. 158. p. 578. In Jamaica, by Sir Will. Beeston, n. 220. p. 225.

The lowest degree of the Barometer; by the Bp. of Cloyne, n. 243. p. 293. The Agreement of the Barometers at London and Townley; by Mr. Townley, n. 203. p. 56.

inch lower here than there, by reason that we are seated though in a seeming Valley, in respect of the Neighbouring Grounds, yet we are considerably higher than the other low Lands near the Sea, where the Standard differs little from that at *London*. In confirmation of what I have said, I suppose you may not be displeased with two remarkable Observations, made both by Mr. *Flamsteed* and me at the same time, viz. Nov. 18, 1674, when finding the Mercury to descend both very fast and very low, we watched it very nicely, and both of us observed, that at 2 in the Afternoon it was rather falling, and rather rising at 4; at which times the height was only here 27, 63 inches, and at *London* $\frac{3}{4}$ higher.

A Portable
Barometer;
by Mr. Will.
Derham, n.
236. P. 3.

V. Provide a strong Glass Tube. Let the Head of it be pinched at about an inch from the Top, so as to make a Narrow Neck, whose Orifice shall be as big almost as a Straw. This (which is Mr. *Quare's* way) will much bridle the blow of the Mercury against the Top, as it danceth up and down, which endangers breaking off the Top of the Tube. The Bottom of the Tube I would have ground aslant near half an inch, that the bottom of the Tube touching the bottom of the Cistern, the Orifice thereof may lie about the middle of the Mercury in the Cistern; which will prevent the Air getting into the Tube, by reason the Mercury is always about the Mouth of the Tube. The Cistern must be made wide, either of Glass, or close grained Wood; round the Brim of which, on the out-side, must be a Notch to eye on the Leather that is to cover it. When the Tube is filled, cleared of Air, and plunged into the Cistern near full of Mercury, enclose the Mercury with gentle Leather tied very fast round the Tube near the bottom, which being spread over the Cistern, tie it round that also: The Tube and Cistern, thus conjoined with Leather, must be lodged in a Case, made very fit to receive both, where they must lie very fast. Through the Case let 3 or 4 Holes be bored, to let the Air in freely to the Leather that covers the Cistern, which lying close against the Holes, will firmly enough keep the Mercury from running out at them.

To enlarge
the Divisions
of the Baro-
meter; by
Dr. Hook,
n. 185.
p. 241.

VI. 1. To make the more minute Variations in the Air's Pressure sensible, Dr. *Hook* invented the Wheel Barometer. But this did not answer fully the designed exactness, both for that the Mercury being apt to stick against the sides of the Glass, would rise and fall *per saltum* all at once, and because it is very difficult to adjust the apparatus of this Instrument, as also that it is exceeding apt to be out of order, for which reasons it is at present almost wholly laid aside.

Upon this in *June* 1668, (as appears on the Journal of the *Royal Society*) he bethought himself of another Device to do the same thing, which was to encrease the divisions, by putting coloured Spirit of Wine, or some other Liquors not capable of freezing, on the Mercury, which Liquor was made to rise as the Mercury fell, and fall as it rose, in a narrow Cane, so as to make the utmost Limits about two foot asunder. But yet he was not satisfied, till he had found out the means of encreasing the Divisions of the Barometer *ad libitum*, which he produced before the *Royal Society* at their Meeting on *Feb. 3, 1685, ft. vet.* The Contrivance whereof is this:

The

The Cylinder *A*, may be of what Diameter you please, the bigger the better; but it need not be above 2 inches long, the Cane *AD*, must be so long that the upper part of the Cylinder *B* may be 29 inches $\times$ such a part of the height of the other Cane *BC*, as the weight or specifick Gravity of the Liquor that is to fill that Cane is to the specifick Gravity of Mercury, below the Line *AB*, in the Cylinder *A*. The third Cylinder *C*, may be as high as you please above the Cylinder *B*, but is most conveniently made, so as the square of the Diameter of the Cane *BC*, be to the square of the Diameter of the Cylinders *B* or *C*, (which must be exactly equal) as the rise of the Mercury in the Cylinder *B*, is to the whole length of the Cane *BC*: For in this case there will be nothing superfluous, but the divisions enlarged to the utmost advantage.

As to the method of filling this Baroscope, tho' the Inventor hath not as yet declared his own contrivance for the doing it, yet it will not be unnecessary to shew here how it may be done. One way (and the best that occurs at present) is to leave a small hole at the top of the Cylinder *A* and another near the top of the Cylinder *B*, this latter being well stoppt, pour in as much Mercury at the other hole in *A*, as shall fill both Canes as high as the level of the said hole; which done, stop either by hermetically sealing it, or else by a drop of Seal-wax (the Glass being first ground rough to make it stick) in the hole *A*; then opening the hole in *B*, draw off as much of the Mercury of the Cane *BC* till it will run no longer: Which done, stop firmly the hole in *B* (which may be done as you please, there being no Pressure against you) and you will have the Cylinder *A*, evacuated of Air, for your purpose; and the height of the Mercury will be as is usual in the ordinary plain and Wheel Barometers. Then pour into the Cane *BC* as much Spirit of Wine tinged with Cochinele, and Oil of Turpentine, equal parts of each, as shall stand above the surface of the Mercury so many feet as you make the enlarged scale of your Barometer, or as is between the middle of the Cylinders *B* and *C*, and you will find the Mercury sink in the Cane *BC*, and rise in the other Cane *AD*, in such proportion, that each 13 foot of Oil and Spirit, will raise the Mercury 10 inches: This done, you must pour on, by the Cane *BC*, so much Mercury as may fill up the Cylinders *A* and *B*, to such heights, considering the present weight of the Atmosphere, that the surface of the Mercury in both, may at the utmost Limits, (which have not in *England* been found to exceed 30, 6 and 28, 6 inches) always fall within the bodies of the Cylinders, and never enter into the Canes.

Here note; That these Liquors are chosen upon two accounts; First, they are exceeding near of a weight, and Spirit of Wine highly rectified is somewhat lighter than Oil of Turpentine, but by a very small addition of Phlegm or Water, the Spirit will preponderate and be undermost; so that you may make them as near of a weight as you please, and consequently a Cylinder of the Oil insensibly differing from an equal Cylinder of Spirit of Wine. Secondly, they are Liquors that will not mix; so that the Oil of Turpentine swimming on the Top, will be divided by a Line only from the tinged Spirit of Wine, which the Oil will keep from evaporating.

The Effect of this Baroscope will be, that when the Atmosphere is heavy, and the Mercury raised high in the Cylinder *A*, and retired out of *B*, the Spirit of Wine will descend into the Cylinder *B*, and the Oil of Turpentine will fill the Cane, so as to make the partition of the two Liquors near the Cylinder *B*. But on the contrary, when the Air is light, the Mercury will sink in *A*, and rise in *B*, so as to drive the Spirit of Wine into the Cane, and the Oil of Turpentine into the Cylinder *C*, so that the Section of the two Liquors will be near *C*, and the Variation of the height of the Mercury will be enlarged into almost the length of the Cane, without that the Counter-pressure from the Liquors will be in the least altered, the height and weight of the incumbent Cylinders being always the same.

That little alteration that may happen by the dilatation and contraction of the Spirit of Wine by heat and cold, which ought to be accounted for, may be best discovered by a Thermometer hanging by it, (containing the same quantity of the Spirit of Wine, and whose Cane is, as near as may be, of the same Diameter with the Cane *BC*, in the Barometer) whose Descent and Ascent must be added and subtracted to reduce it to a rigorous exactness; but it is still worth while to enquire if the Mercury it self do not shrink and swell with cold and heat, so as not to need this correction.

By ——— 2. *A*. The head of the Tube, with its narrow Neck, to bridle the Blow
n. 236. p. 4. of the Mercury, as formerly directed for a portable Barometer.
Fig. 2.

B. The bottom ground afloat.

C. The Crook.

DD. The Weather Plates.

By bending the Tube more or less at *C*, an inch of perpendicular height may be made 2 or 3 inches.

By Mr. Der- 3. *AA*. A Ruler with teeth on one edge of it, made to slide up and down.
ham, n. 237. *b*. A little Finger, fixt to the Ruler, which must be raised or depressed
p. 45. till it point exactly to the height of the Mercury.
Fig. 3.

CCCC. The Index Wheel containing just as many Teeth as there are Teeth in an inch of the sliding Ruler; so that thrusting up and down this toothed Ruler, you may at every inch turn round the Index once.

DDDD. A Circle, divided into 100 parts, answering to 100 parts of an inch on the sliding Ruler.

ee The Index, which being fastned to the Arber of the Index Wheel, is driven round with it, and shews on the Circle, the parts of an inch which the Mercury riseth or falleth in the Tube.

Fig. 3. 4. *A* A long square Table. Towards one end is erected a square Column,
By Mr Steph. *BB*. Upon which there slides a square Socket *C*. From one side whereof pro-
Gray, n. ceeds a crooked Arm, *DE*. At *D* there is a Screw-hole to receive the Screw,
240. p. 176. and at *E* a Ring to support the Tube of the Microscope *F*. From the other
Fig. 4. side the Socket comes a short Arm *G*, having a Screw-hole to receive the long
Screw *H*, whose length may be about 6 or 7 inches: Its lower end, by a small
hole in its Center, rests on the end of a small Screw, that comes through the
Screw-hole, in the Arm *H*, which is fixed on the backside of the Column; the
upper end of the Screw is filed less than the Body of the Screw, and goes
through the Center of the round Plate without shaking; and to prevent its
doing

doing so, either upwards or downwards, there is added a springing Plate *n*, which keeps the Shoulder of the Screw close to the underside of the Plate *K*; over this Plate there goes an Index *o*, and over that an Handle *L*, upon the end of the Screw which comes thro' the Center of the Plate, which I should before have told you, is riveted to the top of the Column *BB*. The Teeth of the Screw must be of that Size, as to have just 10 in an inch. The foreside of the Column must be divided into Inches and Tenths, beginning about the Height of the Socket *H*, where the lower end of the Screw rests, and so continue to the Top of the Column. The Limb of the round Plate must be divided into an 100 Parts. In the Focus of the Eye-glass of the Microscope is fixed an Hair, or very fine silver Wire, in an Horizontal Position.

When you use this Instrument, take hold of the Handle, and looking through the Microscope, turn the Screw till you have brought the Hair to touch, as it were, the Surface of the Mercury *m*; then observe what Divisions are cut on the Column, by the upper or under edge of the Socket, which are tenths of an Inch. See likewise to what Parts the Index points on the Limb of the round Plate, which are Hundreds of a Tenth or Thousand Parts of an Inch; when you perceive the Mercury varied, raise or depress the Microscope, till the Hair be brought to its Surface, as before; then by subtracting the lesser from the greater of the two observed Numbers, you will have the Variation in inches and thousand parts.

This Instrument becomes a Micrometer on the same Principles, though I was obliged to alter its Structure from that used with the Telescope, which was first invented by Mr. *Gascoign*, improved by Mr. *Townley*, and described by Dr. *Hook*.

The Thermometer is also capable of the like Improvement.

VII. 1. May 26, 1697, between one and two in the Afternoon, on the top of *Snowdon Hill* I thrice repeated the *Torricellian* Experiment, and as often found the Height of the Mercury 26, 1 Inches. And being come down to *Llanberris*, at the Foot of the Hill, about 6 that Evening, I as often found it 29, 4 inches. The next Day about 8 in the Evening I found the Mercury by a triple Experiment, to stand at 29, 9 inches, very near the Surface of the Sea; when at the same time, at *Llanerch* in *Denbyshe* (about 25 Miles East from *Snowdon*, and 6 from the Sea, several Foot above the Surface of it) by Mr. *Davis's* standing Barometer it was above 29, 7½. And the Air continued both before and after in the same State. Hence I conclude, that the Difference of the Air's Pressure on the Sea, and on the Top of *Snowdon*, is rather more than 3 Inches 8 Tenths. I could have wished for one of Mr. *Hunt's* portable Barometers, which will certainly be accurate enough for taking the Levels for bringing of Water from distant Places, and certainly much less subject to Error; there being a Tenth of an Inch for each 30 Yards, which may be divided into many Parts evidently. *Snowdon* was measured by Mr. *Caswell*, with *Adam's* Instruments, to be 1240 Yards high; which abating the Height of the Mercury 3 Inches 8 Tenths, may serve for a Standard, till a better be obtained on a higher Place.

The Height of the Mercury at the top of Snowdon Hill; by Mr. Halley, n. 229. p. 582.

Considered;
by Dr. Wal-
lis, n. 233.
p. 653.

At the top of
the Monu-
ment; by
Mr. Der-
ham, n.
236. p. 2.

2. This Observation had been more useful, had it been repeated at several other perpendicular Heights in the Ascent. For from such comparative Observations, we may make a Judgment of the Height of the Atmosphere.

VIII. In Sept. 1696, I observed the Variation of the Mercury on the Monument, and found by one of Mr. Quare's best portable Barometers, that it descended $\frac{1}{16}$ of an Inch at the Height of 80 Feet, and $\frac{2}{3}$ at 160 Feet.

But since that, finding my Observations a little different from Mr. Halley's on Snowdon Hill, I tryed it again more nicely, in Nov. 1697, after this Manner. I provided a pretty large glass Tube well cleaned: This I lodged in wire, and fill'd it with well strain'd Mercury; which being clear'd of all Air, I then plung'd the bottom of the Tube into a broad Cistern of Mercury, and then fixed both the Tube and Cistern together, in a wire Case or Frame. On the top I left an Eye in the Wire, to suspend the whole Barometer on a String, that it might hang pendulously, which is absolutely necessary, because if the Cistern be deeper on one side than another, or if the Tube hang more towards one side than the other, it will cause a great and erroneous Variation in the Mercury above, according as the Tube stands perpendicularly, or not.

My Instrument being thus (I think) very nicely prepared, I marked exactly the height of the Quick-silver, upon 2 narrow Labels of Paper, pasted on each side the Tube, both at the Bottom, and in my Ascent up the Monument. The Differences of the Mercury's Height I measured with a Decimal Inch Scale of thin Brads. The Quantity of my Ascent I measured with a Gunter's Chain, because a String would stretch. By the nicest Observation I could make, I found that at the Height of 82 Feet, the Mercury fell $\frac{1}{16}$ of an Inch, and about 164 Feet $\frac{2}{16}$.

By tarrying above somewhat long, I perceived the Pressure of the Atmosphere was somewhat altered, so that the Mercury in my Descent was about 0,01 of an Inch different from my Observations in ascending. Upon which, I repeated my Experiment, by ascending and descending quicker. At both which Times, my Observations agreed exactly with the first Tryal. From whence I conclude, that at every 82 Feet Height, or thereabouts, the Mercury will descend $\frac{1}{16}$ of an Inch. But I am inclined to think, that the Mercury riseth or falleth sometimes more, sometimes less at one and the same Height. As for Instance, if the Mercury sinketh 0,1 of an Inch, at the Height of 82 Feet, when the Mercury standeth at 30 Inches in the Barometer, I query, whether it will sink so much when the Barometer is at 29 inches.

IX. It has been shown by undoubted Experiments, that the specifick Gravity of the Air, near the Earth's Surface, to that of Water, was once as 1 to 840, again as 1 to 852, and a 3d Time, in a very large Vessel holding ten Gallons, as 1 to 860; all which, considering the Difficulty of the Experiment, agree well enough, the Mercury standing at all those Times about 29 Inches $\frac{1}{2}$; but by Reason 'twas Summer Weather, and consequently the Air rarified, when all these were tryed, we may without sensible Error say in round Numbers, that the Barometer standing at 30 inches, and in a mean state of Heat and Cold, the specifick Gravity of the Air to Water, is as 1 to 800. By the like Tryals the Weight of the Mercury to Water,

n. 237,
p. 46.

The heights of
the mercurial
Cylinder at
any Elevation
above the
Surface of
the Earth;
by Mr. Hal-
ley, n. 181.
p. 104.

Water, is as $13\frac{1}{2}$ to 1, or very near it, so that the Weight of Mercury to Air is at 10800 to 1, and a Cylinder of Air of 10800 inches, or 900 Feet, is equal to an Inch of Mercury, and were the Air of an equal Density like Water, the whole Atmosphere would be no more than 5,1 Miles high, and in the Ascent of every 900 Feet the Barometer would sink an Inch. But the Expansion of the Air encreasing in the same Proportion as the incumbent Weight of the Atmosphere decreases, that is, as the Mercury in the Barometer sinks, the upper Parts of the Air are much more rarified than the lower, and each Space answering to an Inch of Quick-silver, grows greater and greater, so that the Atmosphere must be extended to a much greater Height.

These Expansions of the Air being reciprocally as the Heights of the Mercury, it is evident, that by the Help of the Curve of the *Hyperbola* and its *Asymptotes*, the said Expansions may be expounded to any given Height of Mercury; for by the 65th *Prop. Lib. 2. Conic. Mydorgii*, the Rectangles *ABCE*, *AKGE*, *ALDE*, &c. are always equal, and consequently the Sides *CB*, *KG*, *LD*, &c. are reciprocally as the Sides *AB*, *AK*, *AL*, &c. If then the Lines *AB*, *AK*, *AL*, be supposed equal to the Heights of the Mercury, or the Pressures of the Atmosphere, the Lines *CB*, *KG*, *LD*, answering thereto, will be as the Expansion of the Air under those Pressures, or the Bulks that the same Quantity of Air will occupy; which Expansions being taken infinitely many, and infinitely little, (according to the *Method of Indivisibles*) their Sum will give the Spaces of Air between the several Heights of the Barometer; that is to say, the Sum of all the Lines between *CB* and *KG*, or the Area *CB, KG*, will be proportioned to the Distance or Space intercepted between the Levels of two Places in the Air, where the Mercury would stand at the Heights represented by the Lines *AB*, *AK*; so then the Spaces of the Air answering to equal Parts of Mercury in the Barometer, are as the Areas *CBKG*, *GKLD*, *DLMF*, &c. These Areas again are, by the Demonstration of *Gregory of St. Vincent*, proportionate to the Logarithms of the Numbers expressing the *Rationes* of *AK* to *AB*, of *AL* to *AK*, of *AM* to *AL*, &c. So then by the common Table of Logarithms, the Height of any Place in the Atmosphere, having any assigned Height of the Mercury, may most easily be found: For the Line *CB* in the *Hyperbola*, whereof the Areas design the Tabular Logarithms, being 0,0144765; 'twill be as 0,0144765, to the Difference of the Logarithms of 30, and any other lesser Number, so 900 Feet, or the Space answering to an Inch of Mercury, if the Air were equally prest with 30 Inches of Mercury, and every where alike to the Height of the Barometer in the Air, where it will stand at that lesser Number of Inches: And by the Converse of this Proportion may the Height of the Mercury be found, having the Altitude of the Place given. From these Rules I derived the following Tables.

Given Heights of the Mercury.		Altitudes.		Given Altitudes.		Heights of the Mercury.	
Inches		Miles	Feet	Feet		Inches	
30	_____	_____	0	0	_____	30, 00.	_____
29	_____	_____	915	1000	_____	28, 91.	_____
28	_____	_____	1862	2000	_____	27, 86.	_____
27	_____	_____	2844	3000	_____	26, 85.	_____
26	_____	_____	3863	4000	_____	25, 87.	_____
25	_____	_____	4922	5000	_____	24, 93.	_____
20	_____	_____	10947	Miles 1	_____	24, 67.	_____
15	_____	_____	18715	2	_____	20, 29.	_____
10	_____	_____	29662	3	_____	16, 68.	_____
5	_____	_____	48378	4	_____	13, 72.	_____
1	_____	_____	91831	5	_____	11, 28.	_____
0,5	_____	_____	110547	10	_____	4, 24.	_____
0,25	_____	_____	129262	15	_____	1, 60.	_____
0,1	_____	29 or	154000	20	_____	0, 95.	_____
0,01	_____	41 or	216169	25	_____	0, 23.	_____
0,001	_____	53 or	278338	30	_____	0, 08.	_____
				40	_____	0, 012.	_____

Upon these Suppositions it appears, that at the Height of 41 Miles, the Air is so rarified as to take up 3000 Times the Space it occupies here, and at 53 Miles high it would be expanded above 30000 Times; but 'tis probable, that the utmost Power of its Spring cannot exert it self to so great an Extension, and that no Part of the Atmosphere reaches above 45 Miles from the Surface of the Earth.

This seems confirmed from the Observations of the *Crepusculum*, which is observed commonly to begin and end when the Sun is about 18 *Deg.* below the *Horizon*; for supposing the Air to reflect light from its most rarified Parts, and that as long as the Sun illuminates any of its Atoms, they are visible to an Eye not intercepted by the Curvity of the Earth, it will follow that the Proportion of the Height of the whole Air, to the Semidiameter of the Earth, is much about as 1 to 90, or as the Excess of the Secant of about 8½ *Deg.* to Radius. For if *E* be the Eye of the Observer, *S* a Place where the Sun sets at the End of Twilight in *E*, and the Arch *ECS*, or *TCA*, be found 18 *Deg.* the Excess of the Secant of half thereof *ECH*, would be the Height of the Air, viz. *GH*: But the Beam of the Sun *ASH*, and the visual Ray *EH*, do each of them suffer a Refraction of about 32 or 33 *Min.* whereby being bent inwards from *H*, towards *G*, the Height of the Air need not be so great as if they

they went streight; and having from the Angle $EC S$, taken the double Refraction of the *Horizontal Ray*, the half of the Remainder will be $8\frac{1}{2}$ Deg. *cir- citer*, whose Secant being 10111, it follows that as 10000 to 111, so the Semi-diameter of the Earth supposed 4000 Miles, to 44,4 Miles; which will be the Height of the whole Air, if the Places E, S , whose visible Portions of the Atmosphere $ERZH$, and $SHKB$, just touch one the other, be 18 Deg. asunder.

At this Height the Air is expanded into above 3000 Times the Space it occupies here, and we have seen the Experience of condensing it into the 60 Part of the same Space, so that it should seem, that the Air is a Substance capable of being compressed into the 180000 part of the Space it would naturally take up, when free from Pressure: Now what Texture or Composition of Parts shall be capable of this great Expansion and Contraction, seems a very hard Question; and which, I suppose, is scarce sufficiently accounted for, by the comparing it to Wooll, Cotton, and the like springy Bodies.

'Tis true, the Weight of the whole Atmosphere is various, being counterpoised sometimes by $28\frac{1}{2}$ Inches of Mercury, and at other Times by no less than $30\frac{1}{2}$, so that the under Parts being pressed by about a 15th Part, less Weight, the specifick Gravity of the Air upon that score, will sometimes be a 15th Part lighter than another; besides, Heat and Cold does very considerably dilate and contract the Air, and consequently alter its Gravity, to which add the Mixture of Effluvia or Steams rising from almost all Bodies, which assimilating into the Form of Air, are kept suspended therein, as Salts dissolved in Liquors, or Metals in corroding Menstrua, which Bodies being all of them very much heavier than Air, their Particles by their Admixture must needs encrease the Weight of that Air they lie incorporated withal, after the same manner as melted Salts do augment the specifick Gravity of Water. 'Tis also true, that the Condensations are not possible beyond certain Degrees, for being compressed in an 800th Part of the Space it takes up here, its Consistence will be equally dense with that of Water, which yields not to any Force whatsoever, as hath been found by several Experiments tried here, and at *Florence* by the *Academia del Cimento*, nor can the Rarefaction proceed *in infinitum*; for supposing the Spring whereby it dilates it self, occasioned by what Texture of Parts you please, yet must there be a determinate Magnitude of the natural State of each Particle, as we see it is in Wooll, and the like, whose Bodies being compressible into a very small Space, have yet a determinate Bulk which they cannot exceed, when freed from all manner of Pressure.

These Objections disturb the Geometrical Accuracy of these Conclusions drawn from the specifick Gravity of the Air, observed at any Time; but the Method here shewn will compute, by a like Calculation, the Heights of the Quick-silver, and the Rarefactions of the Air from any assigned Height of the Barometer at the Earth's Surface, and any specifick Gravity given. As to the Condensation and Rarefaction by Heat and Cold, and the various Mixtures of aqueous and other Vapours, these two Objections seem generally to compensate each other; for when the Air is rarified by Heat, the Vapours are raised most copiously, so that tho' the Air properly so call'd, be expanded, and consequently lighter, yet the Interstices thereof being croud-

ed full of Vapours of much heavier Matters, Bulk for Bulk, the Weight of the Compositum may continue much the same; at least a most curious Experiment made by the ingenious Mr. *John Caswel* of *Oxford*, upon the Top of *Snowdon Hill* in *Caernarvanshire*, seems to prove that the first Inches of Mercury have their Portions of Air near enough to what I now determine; for the Height of the Hill being 1240 Yards, or very near it, he found the Mercury to have subsided to 25,6 Inches, or 4 Inches below the mean Altitude thereof at the Level of the Sea, and the Space answering to 4 Inches, by my Calculation should be 1288 Yards; and it agrees as well with the Observation in the Appendix to M. *Pascal's* Book, *de l'Equilibre des Liquers*, made on the high Hill in *Auvergne*, call'd *Le Puy de Domme*. So that the Rarefaction and Vapours seem not to have alter'd considerably the Gravity of the under Parts of the Air; and much above the Height where these Experiments were made, do few Vapours ascend, and the Cold is such, that the Snow lies continually, so that for the more elevated Parts of the Sphere of Air there is much less Reason to doubt.

*The Reason of
the Ascent of
the Quick-sil-
ver; by Dr.
Lifter, n.
165. p. 970.*

X. 1. It is observed of the Barometer, that the Quick-silver is not affected with the Weather, or very rarely, let that be either cloudy, rainy, windy, or serene in *St. Helena*, or the *Barbadoes*: and therefore probably not within the *Tropicks*, unless in a violent Storm or Hurricane. The first is affirmed by Mr. *Halley*, who kept a Glass near two Months in the Island of *St. Helena*, and the other of *Barbadoes* stands upon the Credit of our Registers.

2. In *England* in a violent Storm, or when the Quick-silver is at the very lowest, it then visibly breaks and emits small Particles, as I have more than once observed; which Disorder I look upon as a kind of Fretting; and consequently at all Times of its Descent, it is more or less upon the Fret.

In this Disorder of the Quick-silver, I imagine it hath its Parts contracted and closer put together; which seems probable, for that, for Example, the Quick-silver then emits, and squeezes out fresh Particles of Air into the Tube, which encreasing the Bulk of the Air, and consequently its Elasticity, the Quick-silver is necessarily depress'd thereby, that is, by an external Force or Power; and also the Quick-silver must of it self come closer together, in its own internal Parts, that is, descends for both Reasons.

And that much Air is mixed with it, appears from the application of a heated Iron to the Tube, as is practis'd in the purging of it that way; and also for that polish'd Iron will rust, though immers'd in it, as some Philosophers have lately observed.

Now when the Quick-silver rises in the Pipe (which it certainly does both in hot and frosty Weather) it may then be said to be in a natural State, free, open, and expanded like it self, which it seems it ever is within the *Tropicks*, and with us only in very hot and very frosty Weather. But when it descends, it is then contracted, and as it were convulsed and drawn together, as it mostly is in our Climate of *England*, and more or less, as we guess, in all Places on this Side the *Tropicks*. Which Contraction plainly appears from the concave Figure of both Superficies, not only in that of the Quick-silver in the Tube, but also (if well observed) in that which stagnates in the Pot or Dish it self.

The Difficulty seems to lie in the reconciling the same Effect of the Quick-silver's rising in the Tube, from such seemingly different Causes, as great Heat and intense Frost: and those who shall willingly assent to us in one Particular, and grant us Warmth as a probable Cause of its Restitution to its Nature, will yet be at a Stand how to imagine, that great Frost likewise should bring the Quick-silver nearer its own Nature too: I answer, that Salts liquified will coagulate or crystallize, that is, will return to their own proper Natures, both in Cold and in Heat; and therefore, tho' most Men practise the setting them in a cool Cellar for that Purpose, yet some (as *Zwelfer*) advise, as the best Means to have them speedily and fairly crystallized, to keep them constantly in *Balneo*. Thus also the Lympha of the Blood does become a Jelly, if you set it in a cool Place, and the same is by Warmth in like manner inspissated. Again, that it is no new Opinion, that Water is naturally Ice, if no Disquiet from some external Accident hinder. *Bornichius* the learned *Dane* has said something for it: And altho' some may think that what he hath said, was a mere Complement to his own frozen Climate, yet I dare venture to add, in Confirmation of that Doctrine, that Salt is naturally Rock, that is naturally fossile, not liquid, and yet this is most like Ice of any thing in Nature, not only because of its Transparency, but also for its easy Liquefaction, and the sudden Impressions and Changes which Air makes upon it, so that it is scarce to be preserved in its natural State of Crystallization. Also Salts of all sorts seem naturally to propagate themselves in a hard State, and to vegetate in a dry Form. The like is to be observed in Quick-silver, of its being a hard Rock, and also from its Willingness to embrace upon all Occasions a more fixt State, as in its Amalgamizing with almost all sorts of Metals.

It will not be amiss by way of Corrollary, to add a Note or two about healthful and sickly Seasons, more particularly as they may refer to this *Phenomenon* of great Cold and Frost. If therefore Quick-silver and Liquids are nearest their own Natures, and have less Violence done to them, in very cold and very hot Seasons, the Humours of our Bodies, as Liquids, in all Probability must be in some measure accordingly affected. And that therefore Cold is healthful, I argue from the vast Number of old Men and Women, to be found upon the Mountains of *England*, comparatively to what are found elsewhere.

Again, the Blood it self, or the vital Liquor of Animals equivalent to it, is in most kinds of Animals in nature sensibly cold; for that the Species of Quadrupeds and Fowls are not to be compared for Number to Fishes and Insects; There being, in all Probability, by what I have observed, above a hundred Species of these latter Creatures, whose vital Juice is cold, to one of the former: But because we most converse with those whose vital Juice is hot, we are apt to think the same of all.

Again, I have observed, which I offer as an Argument of the little injury intense Cold does to the Nature of Animals: I say, I have seen both Hexapode Worms (which I compare to the tender Embryos of sanguineous Animals, because such are in a middle State) and Flies of divers Sorts hard frozen in the Winter, and I have taken them up from the Snow, and if I

cast them against the Glass, they would endanger the breaking of it, and make it ring like so much hard Ice; yet when I put the Insects under the Glass, and set them before the Fire, they would after a short Time nimbly creep about, and be gone, if the Glass which I whelmed upon them, had not secured them.

2. It hath indeed been noted by a very wise Philosopher, in Contradiction to our *English* Proverb, which says, that *A green Christmas makes a fat Church-yard*; that the last Plague broke out here at *London*, after a long and severe Winter 1665. But I reply, That that was accidentally only, for that Disease is never bred amongst us, but comes to us by Trade and Infection. 'Tis properly a Disease of *Asia*, where it is Epidemical. And therefore, by the Providence of God, we are very secure from any such Calamities as the natural Effect of our Climate. But we are not to judge or prognosticate of the Salubrity or Sickliness of a Year, from foreign Diseases, but the raging of such as are natural to the Men of our Climate.

By Mr. Edm.
Halley, n.
181. p. 110.

2. To account for the different Heights of the Mercury at several times, 'twill not be unnecessary to enumerate some of the principal Observations made upon the Barometer.

The first is, That in calm Weather, when the Air is inclined to Rain, the Mercury is commonly low.

2. That in serene good settled Weather, the Mercury is generally high.

3. That upon very great Winds, tho' they be not accompanied with Rain, the Mercury sinks lowest of all, with relation to the Point of the Compass the Wind blows upon.

4. That *Ceteris Paribus*, the greatest Heights of the Mercury are found upon Easterly, and North-easterly Winds.

5. That in calm frosty Weather the Mercury generally stands high.

6. That after very great Storms of Wind, when the Quick-silver has been low, it generally rises again very fast.

7. That the more northerly Places have greater Alterations of the Baroscope than the more southerly.

8. That within the *Tropicks*, and near them, those Accounts we have had from others, and my own Observations at *St. Helena*, make very little or no Variation of the Height of the Mercury in all Weathers.

Hence I conceive, that the principal Cause of the Rise and Fall of the Mercury, is from the variable Winds, which are found in the *Temperate Zones*, and whose great Unconstancy here in *England*, is most notorious.

A second Cause is the uncertain Exhalation and Precipitation of the Vapours lodging in the Air, whereby it comes to be at one Time much more crouded than at another, and consequently heavier; but this latter in a great measure depends upon the former. Now from these Principles, I shall endeavour to explicate the several *Phenomena* of the Barometer, taking them in the same Order I laid them down. Thus,

1. The Mercury's being low, inclines it to Rain, because the Air being light, the Vapours are no longer supported thereby, being become specifically heavier than the Medium wherein they floated, so that they descend towards the Earth, and in their Fall, meeting with other aqueous Particles, they incorporate

corporate together and form little drops of Rain; but the Mercury's being at one time lower than another is the effect of two contrary Winds blowing from the Place where the Barometer stands; whereby the Air of that Place is carried both ways from it, and consequently the incumbent Cylinder of Air is diminished, and accordingly the Mercury sinks; as for instance, if in the *German Ocean* it should blow a gale of westerly Wind, and at the same time an easterly Wind in the *Irish Sea*; or if in *France* it should blow a northerly Wind, and in *Scotland* a southerly; it must be granted me that that part of the Atmosphere impendent over *England*, would thereby be exhausted and attenuated, and the Mercury would subside, and the Vapours which before floated in those parts of the Air of equal Gravity with themselves, would sink to the Earth.

2. The greater Height of the Barometer is occasioned by two contrary Winds blowing towards the place of Observation, whereby the Air of other Places is brought thither and accumulated; so that the incumbent Cylinder of Air being encreased both in height and weight, the Mercury pressed thereby must needs rise and stand high, as long as the Winds continue so to blow, and then the Air being specifically heavier, the Vapours are better kept suspended, so that they have no inclination to precipitate and fall down in drops, which is the reason of the Serene good Weather, which attends the greater Heights of the Mercury.

3. The Mercury sinks the lowest of all by the very rapid Motion of the Air in storms of Wind. For the Tract or Region of the Earth's Surface, wherein these Winds rage, not extending all round the Globe, that stagnant Air which is left behind, as likewise that on the sides, cannot come in so fast as to supply the Evacuation made by so swift a Current, so that the Air must necessarily be attenuated when and where the said Winds continue to blow, and that more or less according to their violence; add to which that the *Horizontal* motion of the Air being so quick as it is may in all probability take off some part of the perpendicular Pressure thereof; and the great agitation of its Particles is the reason why the Vapours are dissipated, and do not condense into drops so as to form Rain, otherwise the natural consequence of the Air's Rarefaction.

4. The Mercury stands the highest upon an Easterly or North-easterly Wind, because in the great *Atlantick Ocean*, on this side the 35th Deg. of North Latitude, the Westerly and South-westerly Winds blow almost always Trade, so that whenever here the Wind comes up at East and North-east 'tis sure to be check'd by a contrary gale, as soon as it reaches the Ocean; wherefore, according to what is made out in our second Remark, the Air must needs be heaped over this Island, and consequently the Mercury must stand high as often as these Winds blow. This holds true in this Country, but is not a general Rule for others where the Winds are under different circumstances; and I have sometimes seen the Mercury here as low as 29 inches upon an Easterly Wind, but then it blew exceeding hard, and so comes to be accounted for by what was observ'd upon the third Remark.

5. In Calm Frosty Weather the Mercury generally stands high, because (as I conceive) it seldom freezes but when the Winds come out of the Northern

Northern and North-eastern Quarters, or at least unless those Winds blow at no great distance off; for the Northern parts of *Germany, Denmark, Sweden, Norway*, and all that Tract from whence North-eastern Winds come, are subject to almost continual Frost all the Winter; and thereby the lower Air is very much condensed, and in that state is brought hitherwards by those Winds, and being accumulated by the Opposition of the westerly Wind blowing in the *Ocean*, the Mercury must needs be prest to a more than ordinary Height; and as a concurring Cause, the shrinking of the lower Parts of the Air into lesser Room by Cold, must needs cause a descent of the upper Parts of the Atmosphere, to reduce the Cavity made by this contraction to an *Æquilibrium*.

6. After great Storms of Wind, when the Mercury has been very low, it generally rises again very fast; I once observed it to rise $1\frac{1}{2}$ inch in less than 6 Hours after a long continu'd Storm of South-west Wind. The reason is, because the Air being very much rarified, by the great Evacuations which such continued Storms make thereof, the Neighbouring Air runs in the more swiftly to bring it to an *Æquilibrium*; as we see Water runs the faster for having a great declivity.

Equilibre
des Liquers.

7. The Variations are greater in the more Northerly places, as at *Stockholm* greater than at *Paris* (compared by *M. Pascall*) because the more Northerly parts have usually greater storms of Wind than the more Southerly, whereby the Mercury should sink lower in that extream; and then the Northerly Winds bringing the condensed and ponderous Air from the Neighbourhood of the *Pole*, and that again being checked by a Southerly Wind at no great distance, and so heaped, must of Necessity make the Mercury in such case stand higher in the other extream.

8. Lastly, This Remark, That there is little or no Variation near the *Equinoctial*, does above all others confirm the *Hypothesis* of the variable Winds being the Cause of these Variations of the Height of the Mercury, for in the Places above named there is always an easy gale of Wind blowing nearly upon the same Point, viz. *E. N. E.* at *Barbadoes*, and *E. S. E.* at *St. Helena*, so that there being no contrary Currents of the Air to exhaust or accumulate it, the Atmosphere continues much in the same State: However upon Hurricanes (the most violent of Storms) the Mercury has been observed very low, but this is but once in two or three Years, and it soon recovers its settled State about $29\frac{1}{2}$ Inches.

The principal Objection against this Doctrine is, that I suppose the Air some times to move from those Parts where it is already evacuated below the *Æquilibrium*, and sometimes again towards those Parts where it is condensed and crouded above the mean State, which may be thought contradictory to the Laws of *Statics* and the Rules of the *Æquilibrium* of Fluids. But those that shall consider how when once an *Impetus* is given to a Fluid Body, it is capable of mounting above its Level, and checking others that have a contrary tendency to descend by their own Gravity, will no longer regard this as a material Obstacle; but will rather conclude, That the great analogy there is between the Rising and Falling of the Water upon the *Flux* and *Reflux* of the Sea, and this of accumulating and extenuating the Air,

Air, is a great Argument for the Truth of this *Hypothesis*. For as the Sea, over against the Coast of *Essex*, rises and swells by the meeting of the two contrary Tides of Flood, whereof the one comes from the *S. W.* along the *Chanel* of *England*, and the other from the North; and on the contrary sinks below its Level upon the retreat of the Water both ways, in the Tide of Ebb; so it is very probable, that the Air may Ebb and Flow, after the same manner; but by reason of the diversity of Causes, whereby the Air may be set in moving, the Times of these *Fluxes* and *Refluxes* thereof are purely casual, and not reducible to any Rule, as are the Motions of the Sea, depending wholly upon the regular Course of the *Moon*.

XI. 1. The Experiment is briefly this; That a Tube being after the *Torricellian* way filled with Mercury, and before Inversion perfectly purged of Air, doth when inverted remain top full, even to the Height of 75 Inches.

Mr. *Hugens*, to render a probable Cause of this strange Effect, conceiveth That, besides the Pressure of the Air which keeps the Mercury suspended at the Height of about 27 inches, (and of the Truth of which we are convinced by a great Number of other Effects that we see) there is yet another Pressure, stronger than that, of a more subtile matter than Air, which without difficulty penetrates Glass, Water, Quick-silver, and all other Bodies, which we find impenetrable to Air. This Pressure, he saith, being added to that of the Air, is capable to sustain the 75 Inches of Mercury, and possibly more, as long as it Works only against the lower Surface, or against that of the Mercury, in which stands the open End of the Tube: But as soon as it can work also on the other side, (which happens when striking or hitting against the Tube, or intromitting into it a small Bubble of Air, you give way to this matter to begin to act) the Pressure of it becomes equal on both sides, so that there is no more but the Pressure of the Air which sustains the Mercury at the ordinary Height of 29 Inches.

The Cause of the Suspension of the Mercury at an unusual Height; by M. Hugens, n. 86. P. 5027.

If you ask, why the Quick-silver in the Tube of this Experiment does not feel the Pressure of this Matter, even whilst that Vessel is yet full; since M. *Hugens* supposeth, that it pierceth without Difficulty the Glass as well as the Mercury, &c? And why the Particles of this Matter do not joyn together and begin the Pressure, in regard that they go and come thorow the whole Extent of the Mercury, and that the Glass does not hinder their Communication with those that are without?

To remove this Difficulty, which in M. *Hugens*'s own Opinion is very great, he answers, That though the parts of the Matter, by him supposed, do find Passage between those that compose the Glass, Quick-silver, &c. yet they there find not sufficiently large ones for many to pass together, nor to move there with that force which is requisite to separate the Parts of the Quick-silver, that have some Connexion together. And this very same Connexion, he saith, is the Cause that though on the side of the inner Surface of the Glass, which touches the suspended Mercury, many of its Parts be pressed by the Particles of this Matter; yet there being also a great Number of them that feel no Pressure, by reason of the Parts of the Glass, behind which they are placed, they retain one another, and they remain all suspended, because there is much less Pressure on the Surface of the Quick-silver that is contiguous to the Glass, than upon that below, which is all exposed

exposed to the Action of that Matter which makes this second Pressure.

The Ingenious and Candid Author of this Solution acknowledges himself, That it doth not so fully satisfy him, as not to leave some Scruple behind; but then he adds, That that keeps him not from being very well assured of that new Pressure, which he hath supposed besides that of the Air, by reason as well of the Experiment already alledged, as of two others; which he subjoins to this Effect.

First, When two Plates of Metal or Marble, whose Surfaces are perfectly plain, are put one upon another, they do so stick together, that the uppermost being lifted up, the undermost follows without quitting it: And the Cause hereof is justly ascribed to the Pressure of the Air against their two external Surfaces. He taking then two Plates, each of them but about an inch square, being of that Matter of which anciently they made Looking-Glasses, and closing them so exactly together that without putting any thing between the uppermost keeps not only up the other, but sometimes also with it 3 Pounds of Lead fasten'd to the lowermost; and thus they remain together as long as you please. Having thus joyned them, and charged them with 3 Pounds Weight, he suspended them in the Recipient of his Engine, and exhausted it of Air so far as that there remained not enough to sustain by its Pressure as much as an inch height of Water, and yet his Plates disjoined not. He adds, that he made the same Experiment by putting Spirit of Wine between the two Plates; and found that in the Recipient evacuated of Air they sustained, without being severed, the same weight they did when it was full of Air. This he thinks shews clearly enough, that there remains yet in the Recipient a Pressure great enough after that of the Air is thence taken away; and that there is no more Reason to doubt of it, than of the Pressure of the Air it self.

The *Second* Experiment is, That whereas the Effect of a Siphon of unequal Legs, by which you make the Water of a Vessel to run over, is no longer ascribed to *Fuga Vacui*, but to the Weight of the Air which pressing upon the Water of the Vessel makes it rise in the Siphon, whilst on the other side it descends by its Weight; Mr. *Hugens* found a Means to make the Water of the Siphon run after that the Recipient was exhausted of Air, and he saw that with Water purged of Air it did the Effect as well as without the Recipient. The shortest of the Legs of the Siphon was 8 inches long, and its Aperture, of two Lines. And he will not have us doubt whether the Recipient was well exhausted of Air, for he did assure himself of that, as well by finding that there came out no more Air through the Pump, as by other more certain Marks.

And this he takes for a farther Confirmation of his Supposition of a pressing Matter more subtle than the Air. To which he adds, That if you take the Pains of searching to what Degree the Force of this Pressure reacheth, (which he saith cannot be better made than by pursuing the Experiment with Tubes full of Mercury yet longer than those employed by Mr. *Boyle*) it will perhaps be found, that this force is great enough to cause the Union of the parts of Glass, and of other sorts of Bodies, which hold too well together, as not to be conjoyned but by their Contiguity and Rest, as M. *Des Cartes* would have it.

2. I have given an account of this odd *Phænomenon* in my *Treatise de Motu*, Cap. 14. *Schol. Prop.* 13, where I hinted two Reasons (tho' not perfectly satisfied in either :) The one of my own, concerning the Spring of the Air necessary to put heavy Bodies in Motion, not impelled by any other force: The other of my L. *Brounker*, That there might be in the Air yet a greater Weight or Pressure than is necessary for the Height of 29 Inches, in Case there be nothing but the bare Weight of Quick-silver to be supported. I find M. *Hugens* to fall in with that of my L. *Brounker*, save that what we comprehend under the Name of Air, he calls a more subtile Matter: Which alters not the Case at all, but only the Name.

By Dr. J.
Wallis, n.
91. p. 516o.

But surely there must be somewhat more than this subtile Matter, to solve the *Phænomenon*, notwithstanding the two Experiments now alledged by M. *Hugens* in favour of it. For, if this Matter be so subtile as to press through the top of the Glass upon the Quick-silver, (and consequently through the upper upon the neather of the two Marbles,) as is acknowledged (and without which it is no more able to precipitate the Quick-silver while impure, and when it is in part subsided, than when it is pure, and the Tube top full :) I do not see, why it should not Balance it self (above and below) in the same manner as Common Air would do, if the Tube were pervious to it at both Ends, and the Quick-silver, by the Preponderance of its own Weight fall presently. And the answer, That though Glass be penetrated by it, yet not in so copious a manner as where no Glass is, doth not to me solve the Difficulty: Because the same Obstacle doth just in the same manner remain, when the Tube is in part emptied; and when the Quick-silver is unpurged; the Pores of the Glass not being, by either of those, made more open or more pervious. And if we suppose the subtile Matter by Percolation to be strained through with some Difficulty, (as Air or Water would be through a Cloth,) this might possibly cause the Quick-silver, when it does sink, to sink gradually; but not (as we see it) suddenly to fall to the height of 29 Inches.

The Connexion or Cohesion of the Parts of Quick-silver, either each to other, or to the sides of the Glass, which M. *Hugens* supposeth to require for their Separation a greater Force than is in these percolated Particles till they have Room made for them to combine; seems to me the less considerable, because it is not so necessary to separate them from each other, since that they may unseparated slide down by the sides of the Glass; to which it is well known, and visible to the Eye, the Quick-silver is not at all apt to stick, but doth rather decline that Contact; in like manner as we find Water not apt to joyn with Oil or Grease; though Water to Glass, and Quick-silver to Gold, do very readily apply themselves. So that there needs no such Force to disjoyn the Quick-silver from the Glass, whatever there may be for disjoyning its Parts one from another.

If therefore we should suppose the Pressure of the grosser Air downwards on *AB* (the Surface of the stagnant Quick-silver,) and consequently by means thereof upwards at *C*, sufficient only to bear up that in the Tube to the height of *I*; but the superadded Weight or Pressure of the surer Air to hold it up as high as *D*, (75 inches or more) while it is full

Fig. 7.

and the Quick-silver well cleansed, as if so long it could not enter at *D*; but in case it be not so cleansed, or be already sunk to *H*, this purer Air would enter at *D*, and thrust it down to *I*, Counterbalancing the Pressure (at *C*) of the purer but not of the grosser Air (which I take to be the Sum of the Cause assign'd by M. *Hugens* :) I am yet to seek, why it may not as well penetrate *D* at first, to begin the Descent, as afterwards to pursue it; and why not as well begin the Descent when the Quick-silver is well cleansed of Air, as when it is not so; and why also, if the pure Air do freely enter at *D*, it does not presently fall; or, if not freely, why, when it does fall, it falls suddenly and not leisurely from *D* to *I*; especially since so small a Weight as *DH* of pure Air (for the grosser cannot enter,) is very inconsiderable; if not at all, or not freely, pressed by that Incumbent on *D*; and the Adhesion not considerably less, by being separated only at the Top, while it yet continues to touch the Sides.

I am apt therefore, as heretofore, to ascribe the Cause of this *Phænomenon* to the Spring that is in Air, and the want thereof in Quick-silver; For, that in Air there is a Spring or Elasticity, is now undoubted; but in Water cleansed of Air, though many Experiments have been attempted to that purpose, it has not yet been found that there is any: And I am apt to think the like of Quick-silver; though I do not know that this has been yet so rigorously examin'd. Now supposing, That Matter being at Rest will so continue till it be put in Motion by some Force; this Force may be either that of Percussion from some Body already in Motion (which is the Case when the Quick-silver falls by shaking or striking the Tube,) or of Pulsion from a Contiguous Body beginning to move, as by the Expansion of some adjacent Spring, (which is the Case when the Springy Parts of the Air, either left in unpurged, or readmitted in the Quick-silver, by expanding themselves put the Quick-silver in Motion;) or some *Conatus* or Endeavour of its own, such as is that of a Spring, from whatever Cause it be, which I do not here enquire, but has place only in Springy Bodies, and therefore if Water and Quick-silver be not such, they will not on this account put themselves in Motion.

Gravity or Heaviness is reputed to be such a *Conatus* or Pronity to move downwards, and so to put it self in Motion: And the Wonder at present is why it does not so here. But if this which we call Gravity should chance to be not a positive Quality or *Conatus* originally of it self, but only the Effect of some Pulsion or Percussion from without, (which possibly may be the Case, and principally from the Spring of the Air about us) then while this Pulsion and Percussion is wanting (however obviated) the Bodies accounted heavy, will not of themselves begin to fall: which seems to be the present Case.

And this is the more considerable, because we cannot, at least not yet, find, what is the utmost Height at which the Quick-silver thus accumulated will remain suspended; there having been, for ought I know, no Height yet attempted, at which, if cleansed, it will not stand; and that of 75 Inches, considering the Weightiness of Quick-silver, is a very great one, being more than Equivalent to 80 Foot of Water.

My

My Lord *Brounker* doth a little alter the Case, from what I take to be the *Hypothesis* of M. *Hugens*. For he supposeth this purer Part of the Air to be of like Nature with the grosser Part, (which I think M. *Hugens* doth not) and, though finer than the rest, so as to penetrate Glass, which the grosser will not (there being in all sorts of Grains, some greater than others, and which will not pass so fine a sieve) yet of a Springy nature, as the grosser parts are: Which therefore acts, not by its Weight only, but by its Spring; and therefore when once entered, though in a small Proportion acts as effectually at its first Entrance as if the whole incumbent Air had Admission; its Spring being of a like Tensure with that of the outward Air, (as I have heretofore shewed, *Cap. 14. De Motu, Prop. 11, 12, 13.*) but M. *Hugens's* more subtile Matter than Air, though he must allow it Weight, for else its Entrance would be nothing to the purpose, yet whether he allow it a Spring, I cannot tell; nor doth he inform us. And when he says, this more subtile Matter than Air doth without Difficulty penetrate Glass, Water, Quick-silver, and all other Bodies, which we find impenetrable to Air, I know not whether he mean, without any Difficulty, as the Words seem to import, or, as I conjecture by what follows, without great Difficulty, though with some.

But his *Lordship*, if I mistake not, though he allows his Springy, Subtile Matter to penetrate Glass, yet not without Difficulty, and till it have some Room made, as *HD*, wherein it may recollect it self, cannot exert its Spring; and therefore not while top full of cleansed Quick-silver, but so soon as some Room is made for it: Whereas if the Quick-silver be not purged of Air, that little Air remaining doth by its Spring begin the Motion.

He thinks it also not improbable, and if it so prove, it will be a good Confirmation of this *Hypothesis*, that a large but low Tube of Glass (shorter than 29 Inches) may stand top full of Quick-silver, though with a small Hole in the top as at *K*; at least if immersed in Water, in Case Air be too subtile for our Mechanicks.

He might also suitably enough to his own *Hypothesis*, have so explained himself as to allow his more subtile Parts of common Air to penetrate Quick-silver but not Glass; and therefore, in Case of Room for it at *HD*, it might through the stagnant Quick-silver, and that at *C*, pass upwards to *HD*, and there exert its Spring.

There is yet another way of explicating the same *Hypothesis*, without allowing this subtile Matter to pierce the Glass; which is this. Our Common Air being an Aggregate of very Heterogeneous parts, we may well suppose some of them to be Springy, and others not to be so. The Springy parts we may conceive to be so many consistent Bodies, like small Hairs or springy Threads wrapped up in different Forms and variously intangled, and so as to form many Vacuities capable of admitting (what the other Parts of the Air may be supposed to be) some fluid Matter, which may insinuate into those Vacuities (as Water in a Bundle of Rushes,) without disturbing the Texture of those springy Parts; and which may press as a Weight, but not as a Spring, (of which Distinction see *Cap. 14. De Motu, Schol. Prop. 11. & Schol. Prop. 13. p. 729, 730, 732, 733.*) Now if in the *Toricellian* Tube there be a Quantity of such springy Matter, the Spring

hereof will be of equal strength with that of external Air, (and therefore able to counterbalance it, though its Weight be much less,) because admitted with such a Tensure, (*ibid. Prop. 12, 13.*) But if only an unspringy Fluid (which presseth but as a Weight not as a Spring) and this defended by the Glas Tube from any other Pressure, save that of its own Weight; it will still be too weak to force its own way, till its single Weight be equivalent to that which it is to encounter; which is, not only the springy Part of the Air, but also that fluid unspringy Part; which though (because fluid) it would give way to a springy Body pressing through it; yet not to this fluid, like it self, and destitute of such a Spring; and is therefore able to keep it up to a much greater Height than it could do if uncleaned of springy Air: So long, at least, as till some springy Body be admitted, or some Concussion equivalent to it, put it in Motion; but being one in Motion, it will so continue (as a Bullet impelled by Gun-powder, or an Arrow out of a Bow,) till stopped by some positive Force equivalent.

Vid. Inf. §
Penult.

I do not deny, but that this Explication may be subject to some Difficulties and Exceptions; but I think, fewer than that of allowing the Glas penetrable by this subtil Matter. But the best way to settle this Business, is by suitable Experiments.

A Statical
Baroscope; by
Mr. Boyle, n.
14. P. 231.

XII. I caused to be blown at the Flame of a Lamp some Glas-bubbles, as large, thin, and light, as I could then procure, and chusing amongst them one, that seemed the least unfit for my turn (being of the Bigness of a somewhat large Orange, and weighing about 1 Dr. and 10 gr.) I counterpoised it in a Pair of Scales, that would loose their *Æquilibrium* with about the 30th part of a Grain, and were suspended at a Frame. I placed both the Balance and the Frame by a good Baroscope, from whence I might learn the present Weight of the Atmosphere. Then leaving these Instruments together, tho' the Scales being no nicer than I have expressed, were not able to shew me all the Variations of the Air's Weight that appeared in the Mercurial Baroscope, yet they did what I expected, by shewing me Variations no greater than altered the Height of the Quick-silver half a quarter of an Inch, and perhaps much smaller than those. I had the pleasure to see the Bubble sometimes in an *Æquilibrium* with the Counterpoise; sometimes when the Atmosphere was high preponderate so manifestly, that the Scales being gently stirr'd, the Cock would play altogether on that side, at which the Bubble was hung; and at other times (when the Air was heavier) that, which was at the first but the Counterpoise, would preponderate, and upon the Motion of the Balance make the Cock vibrate altogether on its side. And this would continue sometimes many Days together, if the Air so long retained the same measure of Gravity; and (then upon other changes) the Bubble would regain an *Æquilibrium*, or a Preponderance; so that I had oftentimes the Satisfaction by looking first upon the statical Baroscope (as for Distinction's sake it may be called) to foretel, whether in the Mercurial Baroscope the Liquor were High or Low.

If the ground, on which I went in framing this Baroscope, be demanded, the Answer in short may be; 1. That tho' the Glas Bubble, and the Brass Counterpoise at the time of their first being weighed be in the Air, wherein they

they both are weigh'd, exactly of the same Weight; yet they are nothing near of the same Bulk, the Bubble by reason of its capacious Cavity (which contains nothing but Air, or something that weighs less than Air) being perhaps a hundred or two hundred times bigger than the Metalline Counterpoise. 2. That according to the Hydrostatical Laws, if two Bodies of equal Gravity but unequal Bulk come to be weighed in another Medium they will be no longer equiponderant; but if the new Medium be heavier, the greater Body, as being lighter in Specie, will lose more of its Weight than the lesser and more compact; but if the new Medium be lighter than the first, then the bigger Body will out-weigh the lesser: And this Disparity arising from the Change of Mediums, will be so much the greater, by how much the greater Inequality of Bulk there is between the Bodies formerly equiponderant. 3. That, laying these two together, I consider'd that 'twould be all one, as to the Effect to be produced, whether the Bodies were weighed in Mediums of differing Gravity, or in the same Medium, in Case its specifick Gravity were considerably alter'd: And consequently, that since it appeared by the Baroscope, that the Weight of the Air was sometimes lighter, the Alterations of it in point of Gravity, from the Weight it was of at first counterpoising of the Bubble of it, would unequally affect so large and hollow a Body as the Bubble, and so small and dense an one as a Metalline Weight: and when the Air by an Encrease of Gravity should become a heavier Medium than before, it would buoy up the Glas more than the Counterpoise; and if it grew lighter than it was at first, would suffer the former to preponderate.

One Morning early being told of a Mist, I sent to see whether it made the Air so heavy as to buoy up the Bubble; but I did not learn, that that Mist had any sensible Operation on it.

Though a single Bubble of competent Bigness be much preferable, by reason that a far less Quantity and Weight of Glas is requisite to comprise an equal Capacity, when the Glas is blown into a single Bubble, than when it is divided into two; yet I found that the employing of two instead of one, did not so ill answer my Expectations, but that they may for a need serve the Turn instead of the other, than which they are more easy to be procured: and if the Balance be strong enough to bear so much Glas, without being injured, by employing two, or a greater Number of large Bubbles, the Effect may be more conspicuous, than if only a single Bubble (though a very good one) were employed.

This Instrument may be much improv'd by divers Accommodations. As,

1. There may be fitted to the *Ansa* (or Cheek of the Balance) an Arch of a Circle divided into 15 or 20 *Deg.* (more or less, according to the Goodness of the Balance) that the Cock, resting over against these Divisions, may readily, and without Calculation shew the Quantity of the Angle, by which when the Scales propend either way, the Cock declines from the Perpendicular, and the Beam from its *Horizontal Parallelism*.

2. Those that will be so curious, may instead of the ordinary Counterpoise (of Brass) employ one of Gold, or at least of Lead, whereof the latter being of equal Weight with Brass is much less in Bulk, and the former amounts not to half its Bigness.

3. Those

3. Those Parts of the Balance, that may be made of Copper or Brass, without any Prejudice to the Exactness, will by being made of one of those Metals be less subject than Steel, (which yet if well hardened and polished may last good a great while) to rust with long standing.

4. Instead of the Scales, the Bubble may be hung at one End of the Beam, and only a Counterpoise to it at the other, that the Beam may not be burthened with unnecessary Weight.

5. The whole Instrument, if placed in a small Frame like a square Lanthorn with Glass Windows, and a Hole at the Top for the Commerce of the internal and external Air, will be more free from Dust, and irregular Agitations; to the latter of which it will otherwise be sometimes incident.

6. This Instrument being accommodated with a light Wheel, and an Index (such as have been applied by the excellent Dr. Chr. Wren to open Weather-Glasses, and by the ingenious Mr. Hook to Baroscopes) may be made to shew much more minute Variations than otherwise.

7. And the Length of the Beam and Exquisiteness of the Balance, may easily, without any of the foregoing Helps (and much more with them) make the Instrument far exacter than any of those I was reduced to employ. And to these Accommodations divers others may be suggested by a farther Consideration of the Nature of the Thing, and a longer Practice.

Tho' in some respects this statical Baroscope be inferior to the Mercurial; yet in others it has its own Advantages and Conveniences above it.

And 1. It confirms *ad Oculum* our former Doctrine, that the Falling and Rising of the Mercury depends upon the varying Weight of the Atmosphere; since in this Baroscope it cannot be pretended, that a *Fuga Vacui*, or a *Funiculus* is the Cause of the Changes we observe. 2. It shews that not only the Air has Weight, but a more considerable one, than some learned Men, who will allow me to have proved it has some Weight, will admit; since even the Variation of Weight in so small a Quantity of Air, as is but equal in Bulk to an Orange, is manifestly discoverable upon such Balances as are none of the nicest. 3. This statical Baroscope will oftentimes be more parable than the other; for many will find it more easy to procure a Pair of good Gold Scales and a Bubble or two, than a long Cane seal'd, a Quantity of Quick-silver, and all the other Requisites of the Mercurial Baroscope, especially if we comprize the Trouble and Skill that is requisite to free the deserted Part of the Tube from Air. 4. And whereas the Difficulty of removing the Mercurial Instrument has kept Men from so much as attempting to do it even to neighbouring Places; the essential Parts of the Scale Baroscope (for the Frame is none of them) may very easily in a little Room be carried whither one will, without the Hazard of being spoiled or injured. 5. There is not in statical Baroscopes, as in the other, a Danger of Uncertainty, as to the Goodness of the Instruments, by Reason, that in these the Air is in some more, and in some less perfectly excluded; whereas in those, that Consideration has no Place. (And by the way, I have sometimes upon this account been able to discover by our new Baroscope, that an esteemed Mercurial one, to which I compared it, was not well freed from Air.) 6. It being very possible to discover Hydrostatically

cally, both the Bigness of the Bubble, and the Contents of the Cavity, and the Weight and Dimensions of the Glassy Substance, which together with the included Air make up the Bubble) much may be discover'd by this Instrument, as to the Weight of the Air absolute or respective. For when the Quick-silver in the Mercurial Baroscope is either very high or very low, or at a middle Station between its greatest and least Height, bringing the Scale Barometer to an exact *Æquilibrium*, (with very minute Divisions of a Grain) you may by watchfully observing when the Mercury is risen or fallen just an Inch, or a fourth, or half an Inch, &c. and putting in the like minute Divisions of a Grain to the lighter Scale, till you have again brought the Balance to an exquisite *Æquilibrium*; you may, I say, determine what known Weight in the statical Baroscope answers such determinate Altitudes of the ascending and descending Quick-silver in the Mercurial. And if the Balance be accommodated with a divided Arch, or a Wheel and Index, these Observations will assist you for the future to determine readily, by seeing the Inclination of the Cock, or the Degree marked by the Index, what Pollency the Bubble hath, by the Change of the Atmosphere's Weight, acquired or lost. 7. By this statical Instrument, we may be assisted to compare the Mercurial Baroscopes of several Places (tho' never so distant,) and to make some Estimates of the Gravities of the Air therein. As if, for Instance, I have found by Observation that the Bubble I employ weigh'd just a *Drachm*, when the Mercurial Cylinder was at the Height of $29\frac{1}{2}$ Inches, (which in some Places I have found a moderate Altitude) and that the Addition of the 16th Part of a *gr.* is requisite to keep the Bubble in an *Æquilibrium*, when the Mercury is risen an 8th, or any determinate Part of an Inch above the former Station: When I come to another Place, where there is a Mercurial Barometer, as well freed from Air as mine, for that must be supposed, if taking out my Scale Instrument, it appears to weigh precisely a *Drachm*, and the Mercury in the Baroscope stand at just $29\frac{1}{2}$ Inches, we may conclude the Gravity of the Atmosphere not to be sensibly unequal in both these two Places, tho' very distant. And though there be no Baroscope there, yet if there be an Addition of Weight, as for Instance, the 16th Part of a Grain, requisite to be added to the Bubble, to bring the Scales to an *Æquilibrium*, it will appear that the Air at this second Place is at that Time so much heavier than the Air of the former Place was when the Mercury stood at $29\frac{1}{2}$ Inches.

But in making such Comparisons, we must not forget to consider the Situation of the several Places, if we mean to make Estimates not only of the Weight of the Atmosphere, but of the Weight and Density of the Air. For though the Scales will shew, as has been said, whether there be a Difference of Weight in the Atmosphere at the two Places, yet if one of them be in a Vale or Bottom, and the other on the Top, or some elevated Part of a Hill, it is not to be expected, that the Atmosphere in this latter Place, should gravitate as much as the Atmosphere in the former, on which a longer Pillar of Air does lean or weigh.

And the mention I have made of the differing Situation of Places, puts me in mind of something that may prove another Use of our statical Baroscope

roscope; namely, that by exactly poising the Bubble at the Foot of a high Steeple or Hill, and carrying it in its close Frame to the Top, one may, by the Weight requisite to be added to the Counterpoise there to bring the Beam to its *Horizontal* Position, observe the Difference of the Weight of the Air at the Bottom, and at the Top; and in Case the Hill be high enough, at some intermediate Stations: And perhaps when duly improv'd, it may assist Men to estimate the absolute or comparative Height of Mountains, and other elevated Places of the Earth.

*The Use of
Barometers;
by n.
122. p. 593.*

*Thermome-
ters and Ob-
servations
made with
them; by Dr.
J. Beal, n.
55. p. 1114.*

XIII. By accurate Baroscopes we may regain that Knowledge which still resides in Brutes, and we forfeited by not continuing in open Air, as they do for the most part, and by Intemperance corrupting the Crasis of our Senses.

XIV. 1. *Dec.* 26, 1669, in the Morning, the Weather was colder than ever I found it, since I could take it by the Measure of a Thermometer; that is since these 5 or 6 Years. It was very cold, and freezing quick some Days before and after: And yet in this Time the Mercury hath sometimes fallen more than an Inch, without any other Change of Weather than some Gusts of Winds, some Sprinklings of Snow at several times, in all scarce enough to cover the Ground; and some Abatements of Cold more especially when the Sun was up. To note this Degree of Cold more particularly, I must acquaint you, that in my stanch Thermometer, on the said 26 of *December* the Liquor was at $3\frac{1}{2}$ Inches: whereas in ordinary brisk Frosts, it is at 7 Inches. Yet here I must observe, that sometimes the Frost dissolves, when it is at the 7th Figure, and sometimes I find it at the 8th Figure, in a smart Frost. 'Tis warm *May* Weather when 'tis at the 10th Figure, and 'tis not much above the 12th Figure in the hottest Weather of *June, July,* and *August*.

I think it remarkable, that the 7th Inch, and sometimes the 8th in my Thermometer should abide freezing, and the Frost increase till the Liquor descend $4\frac{1}{2}$ Inches; and yet that it should not ascend from the 8th Inch more, than $4\frac{1}{2}$ Inches in our hottest Summer, being hung in the same Place within 18 Inches of the Glass Window, facing the Northwest, and in a little Writing Room in the 2d Row of Buildings. But now I am strongly persuaded, that the Degrees of Heat and Cold are not exactly indicated by the inclosed Spirit of Wine: For when the Snow melted, and the Frost was first dissolved without Sun-shine, the Liquor was not above the Height of $5\frac{1}{2}$ Inches; possibly it retains some part of the Cold a while after the ambient Air becomes more tepid.

*By Dr. J.
Wallis, n.
55. p. 1118.*

2. My Thermoscope was first made in *Dec.* 1664. the whole Height of the small Cylindrick Glass, whose Cavity was about $\frac{1}{4}$ of an Inch Diameter, was about 28 Inches; besides a small Spherical Bowl at the Top, of about $\frac{1}{4}$ of an Inch Diameter, and a Bowl at the Bottom, which contained the Liquor, (being Spirit of Wine tinged with Cochineal) of about 2 Inches Diameter: the Space above the Liquor being at the first Composure of it, void of Air, save what it had out of the Liquor, which being warm at the first putting in, filled the whole Cavity, while the Glass was Hermetically seal'd. I placed it so, as never to be exposed to the Sun, but in a Room that has a Window only to the North; and therefore it gives an Account only of the Tem-

perature of the Air in general, not of the immediate Heat of the Sun-shine. It is so nice, as that my being or not being in my Study, I find to vary its Height sometimes almost $\frac{1}{4}$ of an Inch.

The lowest Mark to which the Liquor did subside in *Jan.* and *Feb.* 1664, ^{n. 55. P. 1118.} was at $12\frac{1}{4}$ Inches: at $14\frac{1}{2}$ it was Frost certain; and sometimes at 15, and at $15\frac{1}{2}$ (yet this I often observed, that the Air by the Thermoscope has appeared ^{n. 10. P. 169.} considerably colder, and the Liquor lower, or sometimes when there is no Frost, than at some other times when the Frost hath been considerably hard:) The greatest Height in the Summer following was at 25, 26, $26\frac{1}{2}$.

In *Dec.* *Jan.* and *Feb.* 1665, we had at $14\frac{1}{2}$ Frost certain; sometimes at 15 ^{n. 55. P. 1118.} or higher; and the lowest, to which it did that Winter descend, was $12\frac{1}{4}$. The height in the following Summer 1666, was usually about 19, 20, 21; the highest of all at 25.

In *Dec.* and *Jan.* 1666, it was Frost certain at about $13\frac{1}{2}$, (an Inch lower than the Years before, the Liquor, it should seem, becoming less spirituous) sometimes at 14 or $14\frac{1}{2}$, it was hard frosty Weather at 12, 11, and once at $10\frac{1}{2}$, the Weather being very cold. The usual Height in the Summer following, 1667, was about 19, 20, 21, and the highest at $24\frac{1}{2}$.

The Winter following, 1667, it was scarce certain Frost at 13; but yet sometimes at 14, or a little higher: the lowest, to which it did descend that Winter, (being very mild after *Christmas*) was at 12. And the following Summer, 1668, usually about 18, 19, 20; the highest of all (the Heat of that Summer being but very moderate,) at 22.

The next Winter it was Frost certain, about $12\frac{1}{2}$; but sometimes at 13, or higher: the lowest of all at $10\frac{1}{4}$. And in the Summer following, 1669, the highest of all (being but a cool Summer) not much above 20.

At *Christmas*, 1669, though I found it to be Frost certain about $12\frac{1}{2}$, and something higher than 13; yet hath it come sometimes lower than 8; and particularly *Dec.* 26, in the Morning to $7\frac{1}{2}$, and did not all that Day come so high as 8 Inches. Which being so much lower than ever it had been in any of the precedent Years of my Observation, though it may in part be attributed to the dispiriting of the Liquor, yet principally to the Extremity of the Cold. *Jan.* 1. when the Frost seem'd to relent, it was somewhat higher than 9; and *Jan.* 7, about $13\frac{1}{2}$.

3. The greatest Height, the Spirit did rise to in the Thermometer, was two Divisions below extream hot, when we were near the *Equinoctial*.

XV. Since the same Degree of Heat does not proportionally expand all Fluids; some swelling with a gentle Warmth, and others not till they be considerably hot; some boiling with a moderate Heat, and others not at all; some capable of great Expansion, others increasing very little; it may well be concluded, that no one of them does increase and diminish in the same Proportion with the Heat, and consequently, that the Thermometers graduated by equal Parts of the Expansion of any Fluid, are not sufficient Standards of Heat or Cold.

This will be more evident from the Experiments which I made in the Months of *Feb.* and *Mar.* about 4 Years since, the Weather being reasonably

A Thermometer observed at Sea; by Mr. Ja. Cunningham, n. 264. p. 577. The Expansion of several Fluids, in order to ascertain the Divisions of the Thermometer; by Mr. Edm. Halley, n. 197. p. 650.

cold and not freezing) with Water, Mercury, and Spirit of Wine, wherein the following Particulars were very remarkable.

1. I took a large Bolt-head, holding about $3\frac{1}{2}$ lib. of Water, with a narrow Neck to make the Augment thereof more sensible; and having filled it with Water, and some few Inches up the Neck, I noted exactly to what Mark the Water came; then I immersed it into a Skillet of warm Water, and let it stand so long, till I concluded the warm Water had communicated its Temper to the Water included in the Bolt-head, and I found that tho' the Water were warm, much beyond the Degree of the Summer's Heat, and notwithstanding it was Winter, yet that gentle Heat had scarce any Effect in dilating the Water, so that it scarce appeared to have ascended in the Neck of the Bolt-head. Then I took the Skillet, and set it over the Fire, when it was observable, that the Water as it grew hot did slowly ascend in the Neck, especially at first; but after it began to boil in the Skillet, the Expansion thereof became more visible, and it ascended apace, till such Time as it stopped again, the utmost Effort of boiling Water being able to raise it no higher. Then having made a Mark at the utmost Height whereto it had arisen, I took it out, and had the Satisfaction to observe, that tho' it was not raised so high without a very strong boiling, yet it subsided very slowly, as retaining some time the Space it had acquired from the Heat, even after the Heat was pass'd, and the Glass was so cool as to be touched without burning the Fingers. However the next Morning I found it reduced to the first Mark, where it stood when at first put in, having lost nothing sensible by Evaporation during the Experiment, which I attribute to the length of the Neck wherein the Vapours were condensed into Drops before they reached the Top. Then I examined how much Water would raise that in the Neck to the Mark whereto it had been increased by boiling, and found it was a 26th Part of the Bulk of the first Water, which upon repeated Experiments I found to be true; but it was obvious that Water increasing so very little with all the Degrees of Heat the Air receives from the Sun, was a very improper Fluid to make a Thermometer withal; and besides any freezing Liquor is useless for this Purpose in these Northern Climates.

2. I took a smaller Bolt-head with a proportional Cane or Neck, and filled it after the same manner with Mercury, and having boiled it as above, I observed that 125 Ounces of Mercury had increased the Space of 810 Grains, or a 74th Part of its Bulk when cold. But it was very remarkable, that whereas a gentle Heat had scarce any Effect on Water, here on the contrary, the Mercury did sensibly ascend at first, and had almost attained its greatest Expansion before the Water boiled in the Skillet. And after it boiled, tho' I let it stand very long over the Fire, I could not discern that the most vehement boiling had any Effect on it, above what appeared when it first began to boil. The Mercury being taken out, as it cooled subsided, and in a few Hours returned to the Mark whereto it stood before it was put into the Water. This Fluid being so sensible of a gentle Warmth, and withal not subject to evaporate without a good Degree of Fire, might most properly be applied to the Construction of Thermometers, were its Expansion more considerable.

However

However small as it is, it is sufficient to disturb the precise Nicety of the Mercurial Barometers, shewing the Counterpoise of the Pressure of the Atmosphere by a Cylinder of Mercury; for if Mercury be more expanded, and consequently lighter in warm Weather than in cold, it will necessarily follow, that the same Weight of Atmosphere will require a taller Cylinder in Summer, and a shorter in Winter to counterpoise it. And if the Extremity of Weather do but occasion a 15th Part of Difference, as 'tis probable it doth, the Effect thereof on a Barometer will be a tenth of an Inch above the Mean, or a Fifth in all.

3. I fill'd the smaller Bolt-head with Spirit of Wine, and having set it in the Skillet of Water over the Fire, I found that it ascended gradually as the Heat increased, but slower at first, and faster after it was well warm. At length being arrived at a certain Degree of Heat, it would fall a boyling with great Violence, emitting Bubbles, which coming into the Neck of the Bolt-head, would lift all the incumbent Spirits till they had made their way through. And these succeeding one another very fast, would often raise the Spirit to the Top of the Neck, and spill it; so that I found I could go no further with this Liquor, than to that Degree of Heat which occasioned this boyling, and which wanted very much of that of boyling Water, being almost tolerable to the Touch. It was however very remarkable, how exactly this degree of Heat was determined by the Expansion of the Spirit, for in the Instant it reached a certain Mark on the Neck, it began to emit its Bubbles: and having been taken out a little to cool and subside it would certainly and constantly fall a bubbling again, when upon a 2d Immersion, it was arrived at the foresaid Mark. During this Experiment, it appear'd both by the Dew on the Neck, and by the Scent in the Room, that tho' the Neck were about 30 Inches long, yet the Spirit did evaporate very fast for the smallness of the Surface of the Liquor: And I have often noted the like Evaporations condensed in Dew, within the Head of the ordinary seal'd Thermometers, in very hot Weather.

This degree of Heat which made Spirit of Wine begin to boil, being determined so nicely as I have said, made me conclude, that this might very properly be taken for the Limit of the Scale of Heat in a Thermometer; and the Effect thereof in the Expansion of any other Fluid being accurately noted, might be easily transferr'd to any sort of Thermometer whatsoever. Only it must be observed, that the Spirit of Wine used to this purpose be highly Rectify'd or Dephlegmed, for otherwise the differing Goodness of the Spirit will occasion it to boil sooner or later, and thereby pervert the designed Exactness. And by the way, give me Leave to hint, that the sooner or later boiling of Spirit or spirituous Liquors may possibly be as good a Test of their Strength and Perfection as their specifick Gravity, or any other yet used.

The Spirit of Wine I made use of was possibly none of the best, but I observed that at the point of boiling it had increased a 12th part in bulk, which great Dilatation makes it a Liquor sufficiently adapted to our purpose, were it not for the Evaporation thereof, and for the Difference in Goodness of the Spirit, and for that in length of Time it becomes as it were Effete, and loses gradually a Part of its expansive Power.

Hist. of Cold,
Tit. 18. S. 8.
P. 475.

4. This expansive Power is in no Fluid comparably so conspicuous as in that rare elastick Fluid the Air; for by several Experiments that I have made, I find that the Heat of Summer does expand the ordinary Air about a 30th part; and that late honourable Patron of experimental Philosophy, Mr. Boyle, alledges his own Tryals, proving that the Force of the strongest Cold in England does not contract the Air above $\frac{1}{30}$ part. So that the same Air which in extreme Cold occupies 12 parts of space, in very hot Summer Weather, will require 13 such spaces; which is as great an Expansion as that of Spirit of Wine when it begins to boil: For which Reason, and for its being so very sensible of Warmth and Cold, and continuing to exert the same elastick power after never so long being included, in my Opinion it is much the most proper Fluid for the purpose of *Thermometers*.

Now the Thermometers hitherto in use are of two sorts: the one shewing the different temper of Heat and Cold by the Expansion of the Spirit of Wine, the other by the Air: But I cannot learn that either of them of either sort, were ever made or adjusted, so as it might be concluded, what the Degrees or Divisions of the said Instruments did mean; neither were they ever otherwise graduated, but by Standards kept by each particular Workman, without any Agreement or Reference to one another: So that whatsoever Observations any curious Person may make by his Thermometer, to signify the Degree of Heat in the Air, or other Things, (which is of constant Use in Philosophical Matters) cannot be understood, unless by those who have by them Thermometers of the same Make and Adjustment. Much less has the way been shewn how to make this Instrument without a Standard, or to make two of them agree artificially, without comparing them together.

I shall only add, that whereas the usual Thermometers with Spirit of Wine, do some of them begin their Degrees from a Point, which is that whereat the Spirit stands when it is so cold as to freeze Oil of Anniseeds; and others from the Point of beginning to freeze Water: I conceive these Points are not so justly determinable, but with a considerable Latitude: And that the just beginning of the Scales of Heat and Cold should not be from such a Point as freezes any thing, but rather from Temperature, such as is in Places deep under Ground, where the Heat of the Summer, or Cold in Winter, have (by the certain Experiment of the curious M. Mariotte in the Grottoes, under the Observatory at Paris) been found to have no manner of Effect.

Hygrosopes;
by . . . n.
127. p. 650.
Fig. 8.

XVI. 1. The *Hygroscope* I make use of, I thus contrived. I took two pieces of Deal-board, (*Poplar* would have been better) each about two foot long and a foot or more in breadth, *AB*. These I got well plained and shotten, that their edges might meet even together. Of these two, set edge by edge, I fastened each end between two Ledges of Oak *CC*, of 2 Inches broad, and long enough to reach athwart both boards, (but one ledge, if it be thick enough might be made to serve each End, by making hollow furrows or gutters in it to receive the ends of the boards) and so I fixed both boards in, as Pannels are set in Wainscot. This done, supposing $\frac{1}{4}$ of an Inch to be the utmost distance that

that these two boards would shrink asunder in driest Weather, (for it matter'd not much, though it should be somewhat more or less) I took a thin piece of Brass *D*, of two or three Inches long and $\frac{1}{4}$ Inch broad, and upon one edge, towards the end, I measured $\frac{1}{4}$ of an Inch: (which was the utmost distance I supposed the two boards would gape asunder,) which space *dd*, I divided into five equal parts, and with a small File made them into so many fine teeth, like those of a Watch wheel. This piece of Brass I placed flat, across the juncture of the two boards, nailing its one end by means of two small holes *bb*, to the board *A* only, and leaving the other end, which is the toothed one, free and reaching to a competent distance over the board *B*, to which it had no coherence. Next I made a pinion, (consisting of as many teeth as the Brass had) *e*, upon the end of a piece of thick Iron Wire: This Axle *F*, with its pinion *e*, I so fastned to the other Board *B*, by means of the Brachiolum *E*, and so adapted to the teeth of the Brass-plate, that when the Boards do shrink asunder, the Brass being drawn a little away, must needs turn this Axle (by means of its toothed pinion) more or less; and so if ever it happens, that the Boards gape but a quarter of an inch asunder, this Axle will have made one intire Revolution: Wherefore I put a long Index *GG*, upon the extremity of this Axle, and made a Circle round it with the usual graduations, numbred from what point I pleased, and the Motion of the Index back or forward, shews me the degrees of the Drought or Moisture of the Air. Now this Axle may be made to come through a round Plate of Wood or Metal that hides the contrivance, all but the Hand and Figure, as in a Clock or Watch. 'Tis to be noted moreover, that the Boards must be fastned to the ledges, only at the outer edges, as at *aaaa*, that they may have the more liberty of swelling and shrinking asunder. Tho' the *Hygroscope* which I make use of be none of the best Workmanship, nor exactly made after the Description I have here given you, (the Boards having not liberty of gaping above $\frac{3}{4}$ of an inch) yet I have oftentimes the pleasure of seeing the Index turn 10 or 20 degrees in an Hour or two, and when the Air is changed, will return as swiftly, by the shrinking and swelling of the Boards.

2. *AAAA*, is a Frame of Wood for two Pannels of Deal to play loose in at top and bottom, to which at the two ends they are fastned. *BB*, The two Pannels of slit Deal, three foot deep and three foot broad apiece, with a distance left in the middle for the scope of the Motion *C*, The Hand, placed or fastned by the Axle-tree to the Plate, and also with Nail-holes which are to fasten it to the middle of the Pannel within half an inch of the scope for motion: at the lower or shorter end of which Axle-tree there is, by a Wire like an *S*, fastned a small Silver Chain within a straw's breadth of the Axle-tree; which Chain is to be carried and placed cross the distance between the two Pannels and fastned to the Pannel opposite by a Brass Noose, through which it is to slip, so as that it may be taken up or let down at pleasure. *D*, the Roller with a Weight annexed, which by a string is fastned to the lowest end of the hand *C*; so that as the Relax gives way, the Weight will adjust the Motion of the Hand to the Index *E*. *E*, the Index of Paper, pasted

By Mr. Co-
niers, n. 129.
P. 715.
Fig. 9.

past upon the opposite Pannel to the Hand, and so as it is in this Figure, placed near the Top, for the better advantage of the Hand's Motion; and this Index, being but a quarter of a Circle, is divided into Inches more or fewer according to the Scope which the Pannels Hand requires for their Motion, but when the Relax shall require more room for the Hand then the Chain is to be taken up one Link more, and so you will be ready for more play upwards and downwards: Which taking up may yet be again repeated, when there is occasion, or the Time of Year requires it.

Now if the Chain be placed near the Axle-tree, the Motion will be the nicer and larger; if farther off, then it will be less: For Example, the Motion of 2 more than that of 3, and 3 than that of 4, &c. as you may perceive by the Figures 2, 3, 4, 5, 6; which are placed in this Figure by the lower end of the Hand near below the Axle-tree thereof.

From this Contrivance it was, That I have for this 5 or 6 Years past made these following Observations.

1. That these Pannels of Deal-wood will move by shrinking most in Summer, and swelling most in Winter Seasons; but will vary from this, according to the Change to the then more or less Heat or Cold, Moisture or Drought, that the temper or season of the Year, such as Spring and Fall, do produce; it being then more apt to swell or shrink on the sudden, but not attaining then to the highest shrinking or swelling, as in Summer and Winter it doth.

2. That for the most part, especially in the Spring and Summer time this Motion happens only in the Day time; for then generally all Night it rests and moves very seldom.

3. That one kind or manner of this Motion happens in dry fair Weather, but sometimes in the forepart of the Forenoon, and sometimes not until the latter part of the Forenoon, and then at that time it relaxes or swells the Deal for about two or three Hours; more, seldom; less, often; and then all the Afternoon after shrinks; nay, some times even when a small Rain hath newly fallen, or is then falling; and this not so often, but more seldom in Winter, or cold moist Weather.

4. This Shrinking is gradual very often, or for the most part a little after a moist time (*viz*) the first Day after Moisture it shrinks a little, the second Day more, and so yet more according to the then time of Year, and as it is then inclined to Moisture or Drought, and Alteration of the Wind and the then Heat or Cold.

5. The Winds being in the North, North-east, and East, Winter and Summer, for the most part at that time the Deal shrinks, in the Night also as well as in the Day; but not so much; which is a sign of drying Weather, and sometimes of Frost or Cold in Winter; Heat or Scorching in Summer, in a clear Day. But on the contrary, the South Winds blowing, or the West and South-west, the Deal then always relaxes that Day, or at least is at a Stay provided this happen in the Day time; for then if in the Night, not so much; and so this will do some considerable time before Rain.

6. By a constant Observation of this Experiment of the Deal's Motion and

Rest, you may be able to know or guess at the Wind's Situation without a Weather-cock, provided you have by you a common and a seal'd Thermometer.

7. Also you may know the time of the Year; for in the Spring it moves quicker and more than in Winter; in Summer it is more shrunk than in the Spring; in Autumn less in motion than in the Summer.

I shall only add, that to find whether the Moisture was rarified out of the small Cylinder-like Ends of the Wood only, or out of the Sides also, I took two Pieces of a season'd Deal; the Ends of the one Piece I closed up with Diachylon Plaister, but the Sides of this Deal I did not so close up; but left these sides with the other piece without Diachylon. Both being exposed to the open Air, they were found the next Day both of them alike to have increased in proportion of Weight, which seems to prove that the sides also do take in and let out Moisture.

In a second Contrivance, *AAAA*, is the Frame of Wood, for the Pannels Fig. 10. of Deal to play loose in, at the top and bottom. *BBBB*, the Crosses of Deal or Iron fastned to the Frame on each side; to which is annexed the Circular Index divided into 12; in the Center of which the Axle-tree *b*, for the Hands, is placed. *CC*, the two Pannels of slit Deal, 3 foot deep, and 3 foot broad apiece, fastned at each end of the Frame, with a distance left in the middle for the scope of the Motion.

The inward Work is thus contrived. *AA*, the two Hands. *BB*, the Fig. 11. two Brass Pullies or Rollers, the one bigger, the other less; to the bigger a flat Leaden weight is fastned with a Cat-gut string; to the smaller is fastned a small Silver Chain, which is by the Noose or Loop of the Brass *C*, to be fastned to the Pannel under the middle of the Cross, near the Gap or Scope for the Motion; and in that Noose the Chain to have a fastning to be taken up or let down at pleasure. *D*, the Roller or Pulley to be placed on the other Pannel opposite to the Noose, and near the Gap or Scope, betwixt the two Pannels; over which Roller the small Chain, upon its return to the Axle-tree, is to be placed. *E*, the Axle-tree, upon which the two Rollers or Pullies *Bb*, are to be fastned, and the two Hands *AA*, for the Index. *F*, the Weight annexed to the biggest Roller or Pulley *B*, and the String or Cat-gut to be moved, is to have the contrary Posture for Motion to the small Roller or Pulley upon which the Silver Chain is fastned: So that as the Shrinking of the Pannel moves the Axle-tree one way, the relaxing may give to the moving the Hands or Axle-tree the other way by the Power of the Weights drawing; which contrary Postures will give the nicest Account of this Motion.

The Circumference of the smallest Pulley or Roller *b*, is to be no bigger than just so much scope or distance as the two Pannels make by the extremity of their utmost swelling or shrinking; and so one full Revolution of the Hand upon the Index may answer the fullest shrinking and swelling in the Year, and the distance between the two Rollers or Pullies fixt upon the Axle-tree, must be the thickness of your Pannels; so that the Weight is to play or move on the one side of the Pannel, and the Chain on

on the other, without disturbance or rubbing against the sides of the Pannel or the Cross, between which, out of sight, in the middle they are to be placed.

This way was so contrived 1675, some Years after the former; and so with Chain and Pullies to avoid the shaking that would happen by applying the Work of Pinion and Teeth to move the Hands; which was then also propounded to Mr. *Tompion* the Watch-maker, but by him rejected, tho' I think that way may be used also with a Weight added to regulate the Motion.

The Deal-board should be of the finest straightest grain'd *Dram-deal*, laid a drying in your House two or three Years.

By Mr. Mo-
lyneux, n.
172. p. 1032.
Fig. 12.

3. *AB*, is a Whipcord about four foot long, tied fast to the end of the Hook *A*. At the end of this Whipcord there hangs the Weight *C*, about a Pound or something more; this Weight is so fitted at the end as to receive and carry the Index *D*. Under these there is placed a graduated Circle on the Board *EF*, fixt by a Bragget against the Wall.

All things being thus adapted, the Moisture of the Air twists the Rope, and gives a Motion to the Index over the Divisions in the graduated Circle; and again, as the Air grows more dry, the Cord untwists and brings back the Index by a contrary Motion. The Reason of this is plain; for the little Particles of the Moisture insinuating and soaking into the Cord are like so many Wedges which must needs shorten the Rope, as a Bladder is shortned by being blown up and will lift a great Weight, but the easiest way for the Rope *AB*, to shorten and lift up the Weight *C*, is to do it by way of a Screw; for it self is a Screw, the Stands thereof being twisted (and each particular Thread in it) Screw-wise, and consequently must give a circular Motion to the Index.

To make an Experiment of this; I wetted a Cord and hung it up with the Weight at the end of it, and I perceived as it dried it untwisted, and that too very quick, so as to be perceived by the Eye; after the Cord had so far untwisted, as I thought it had come to that degree of Dryness, that the present Constitution of the Air would permit, I took a Bason of warm Water, that sent out a Steam and Fume, and placed it under the Cord; immediately the Cord began again to twist very quick, and so continued till the Water ceased fuming, or was removed, and then immediately it began to return its twists. I then tryed to breath upon it gently with my Breath, and found according to my Expectation, that 8 or 10 Breathings would twist it 5 degree of a Circle. I then permitted it to the Air only, and I find it to obey the Alterations thereof most nicely; there falls not the least Shower, at which it does not presently twist; and when by rising Clouds a fair Day becomes over-shadowed, the Cord is immediately sensible thereof, and again as sensible of their vanishing and alteration to fair Sun-shine. So that I repute it to be the nicest *Hygrometer* that has ever yet been used, and I am sure is as cheap and plain as any.

One of the grand defects of most (indeed I think of all) *Hygrometers* hitherto invented, is that they grow weak with Age, and do not so nicely obey the Alterations of the Air, when long kept as when first made; but whether our present Invention be subject to the same fault I leave to time to determine.

The

The Alterations also of the Air may give this kind of *Hygrosopes* more than one Turn; now this being inconvenient, and the Duplication of the Turn hard to be registred as Mr. *Hook* proposes, in his *Micrography*, concerning the Beard of a Wild-Oat; I have thought of a way for remedying this, for it being in our Power to increase the Diameter of our graduated Circle as large as we please, what need have we of more than one Turn, from the greatest Degree of Moisture to the greatest Degree of Drought? Now suppose I find this *Hygroscope* to have two compleat Revolutions (this is to be found by Observation throughout a whole Year,) I say then the way of rectifying it is thus. The Index *D*, has two compleat Turns, the Point *A*, as being fix'd, has no Turn or Motion, therefore the middle Point *G*, has but one Turn, and consequently if I hang it up at the Point *G*, or no longer than *GD*, half the former length, the Index *D*, will have but one Turn. What is here said of two Turns and the middle Point *G*, may be accommodated to any other Number of Turns and Parts and Points in the Rope.

If a Candle, or heated Iron, be apply'd nigh the Rope, it makes it twist very quick, contrary to Mr. *Hook's* Oat-beard.

We may in this Experiment perceive something that may help us in the Consideration of the Strength and Motion of the Muscles of Animals; for take a Cord able to sustain an hundred Pound Weight, by the weak Fume or Steam of warm Water this Weight shall be lifted up; for if this Steam turn the Weight (as most certainly it will do, if the Rope be of any moderate Length) the Weight is as certainly lifted up thereby as by a Screw, as is evident to any one that considers it. If therefore such mighty Performances can be produced by the Application of such mean Agents, as we all know and are conversant with, what shall we think is too great for those Parts which God has contrived and framed in the Bodies of Animals.

4. It is observed, that when Oil of *Vitriol* is satiated in the moistest Weather, it afterwards retains or loses its acquired Weight as the Air proves more or less moist. Thus one Grain after its full Encrease often vary'd its *Equilibrium* so sensibly, that the Tongue of the Balance of $1\frac{1}{2}$ Inch long described an Arch of Variation to $\frac{1}{3}$ of an Inch Compass, (which Arch would have been $2\frac{2}{3}$ Inches had the Tongue been but one Foot in length) even with that little Quantity of Liquor; so that if more Liquor expanded under a large Surface be used, the minutest Alteration of Weather must needs very much more affect it, and a bare Pair of Scales will afford an *Hygroscope* as nice perhaps as any yet known.

This Balance may be contrived two Ways, either such whose Pin should be in the middle of the Beam, with a very slender tapering Tongue, of a Foot or one Foot and a half long, pointing to the Divisions on a broad arched Plate, fix'd above in the Handle; or else the Scale with the Liquor may be hung to a Point of the Beam very near the Pin, and the other Extrem made so long as to mark a large Arch on a Board plac'd conveniently for that Purpose. The Scale in either may be a Concave Glass of four or five Inches Diameter. Lastly, on the Division of the Arches should be inscrib'd the different Temperature of the Air shewn by the Liquor.

By Mr. Will.
Gould, n.
156. p. 504.

vid. inf.
Cap. III.

Fig. 13.

Fig. 14.

I have Reason to think that Oyl of Sulphur *per Campanam*, as also Oyl of Tartar *per Deliquium*, and the Liquor of Fixt Nitre, &c. may succeed as well.

Another; by
Mr. Will.
Gould, *ib.*
p. 505.
Fig. 15.

5. Another *Hygroscope* may be made of a Viol-string running upon Pullies, and suspending a Bullet fixt to the shorter End of an Index, whose other Extremity is so long as to describe a long Arch, by the falling and rising of the Bullet upon the stretching and shrinking of the String, which would be more nice, were the Index fastned to the Center of the last Pully.

To observe the
Strength of
Winds; by
... n. 24.
p. 444.
Fig. 16.

XVII. Expose the Instrument *ABCD*, to the Wind, so as the flat Side *CD* may be right against it; the number of Degrees upon the Limb *AB*, to which the Wind blows up, or raises that flat Side, shews the Force or Strength of the Wind, in Proportion to the Resistance of the flat Side of the Instrument.

Remarks con-
cerning the
gradual Al-
teration of the
Temperature
of the Air in
America,
and in Ire-
land; by
... n. 127.
p. 648.

XVIII. That in *America* (at least as far as the *English* Plantations are extended) there is an extraordinary Alteration as to Temperature, since the *Europeans* began to plant there first, is the joint Assertion of them all. This Change of Temperature is, and not without some Reason, generally attributed to the cutting down of vast Woods, together with the clearing and cultivating of the Country. But that *Ireland* should also considerably alter, without any such manifest Cause, doth very much invalidate that Reason. For if it be true, as some compute, that this Kingdom was better inhabited and husbanded before the late bloody War, than at present, it should, according to the Reasons alledged for the Change of Temperature in *America*, be rather grown more intemperate, *viz.* for want of Cultivation: But the contrary is observable here, and every one almost begins to take notice, that this Country becomes every Year more and more temperate. Now whether there were more Inhabitants in *Ireland* before the late War than at present, I shall not here insist upon, neither do I think it an easy Matter to determine; yet sure I am, that there has been no such Increase of People here within these sixteen or twenty Years, nor such Improvements as to be unaccountable for the great Change of Temperature that is of late observed. Within less than the Time newly mentioned, 'twas not unusual to have Frost and deep Snows of a Fortnight and three Weeks Continuance; and that twice or thrice, sometimes oftner in a Winter; nay, we have had great Rivers and Lakes frozen all over; whereas of late, especially these two or three Years last past, we have had scarce any Frost or Snow at all. Neither can I impute this extraordinary Alteration to any fortuitous Concourse of ordinary Circumstances, requisite to the Production of fair Weather, because it is manifest, that it hath proceeded gradually, every Year becoming more temperate than the Year preceding. And I observed particularly, that all the Winter 1674 was very mild, and warmer than could be well expected from such a Season, and but very little Rain: Having in the whole Month of *February* not rained above twice or thrice, (at least in that Part of the Country where I then was:) insomuch that many took upon them to predict, that such unseasonable Weather would certainly be the Cause of some Dearth or Pestilence the ensuing Summer, or Autumn; but their Predictions proved as false as the following Harvest was extraordinary both for Health and Plenty.

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measure
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by Mr.
aley, n.
p. 51.

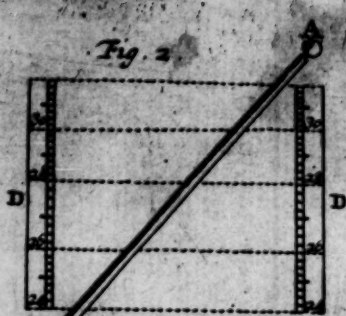


Fig. 2.

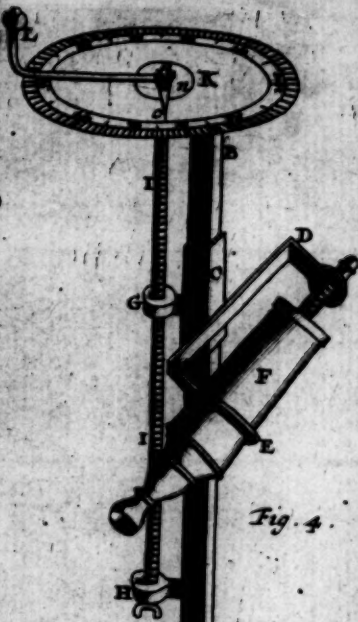


Fig. 4.

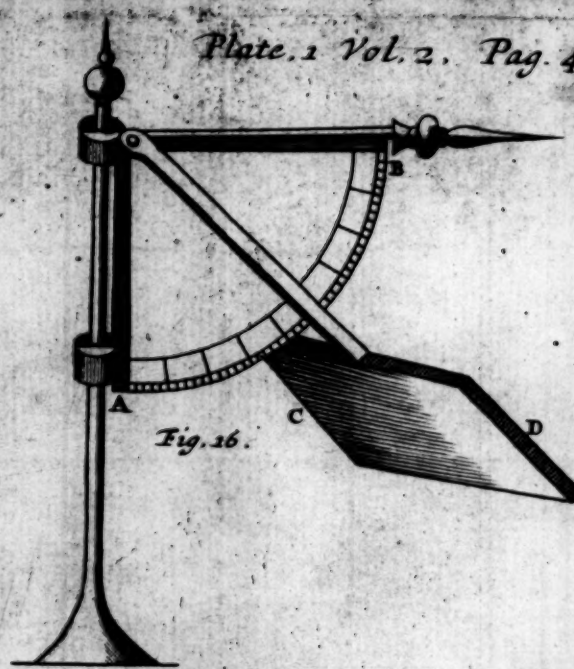


Fig. 16.

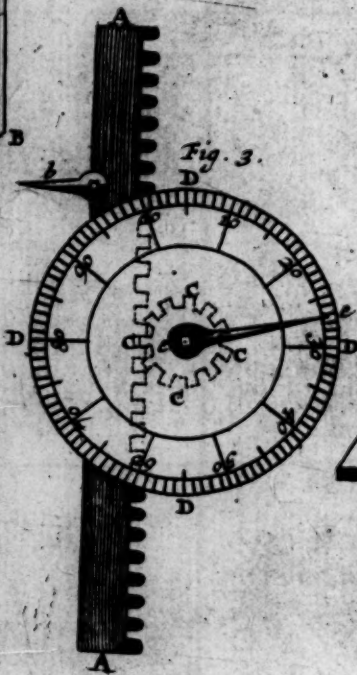


Fig. 3.

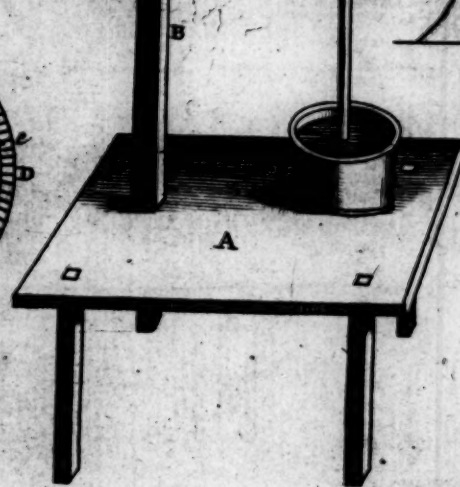


Fig. 5.

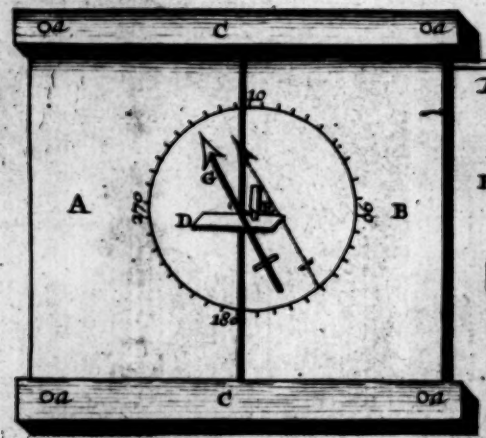


Fig. 6.

Fig. 1.

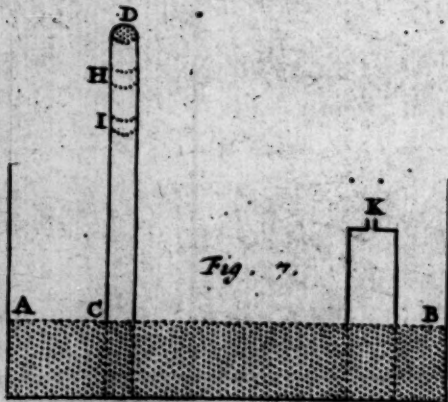
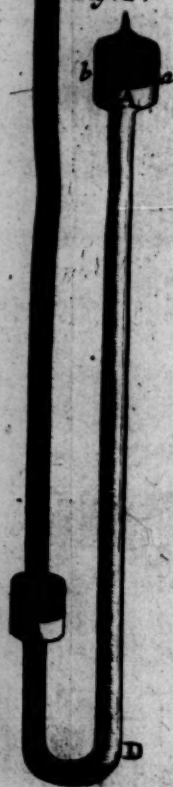


Fig. 7.

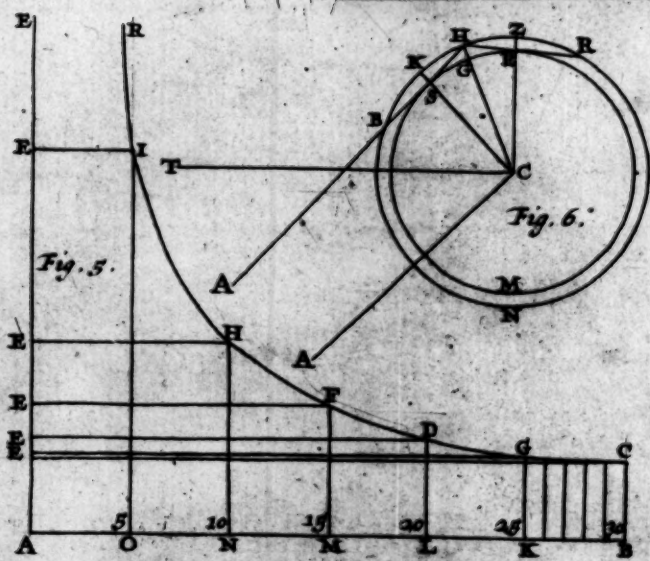
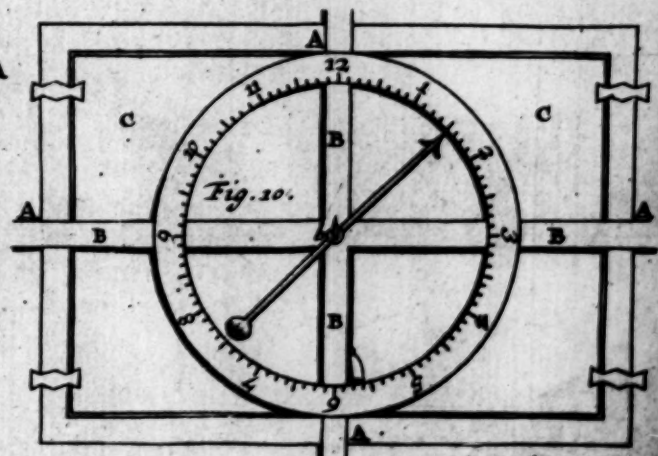
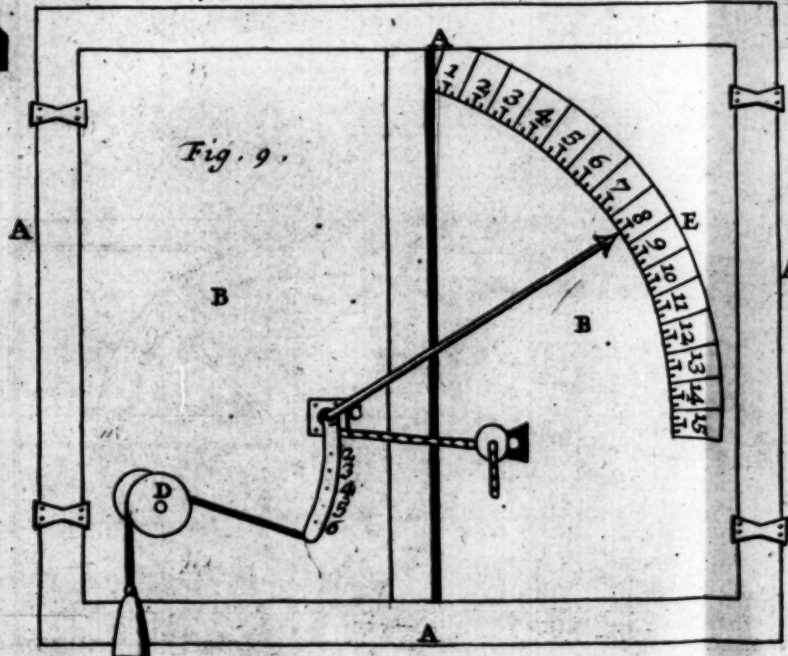
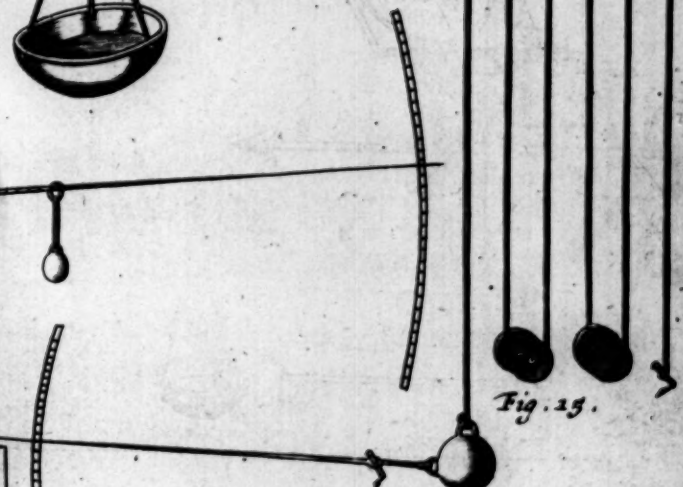
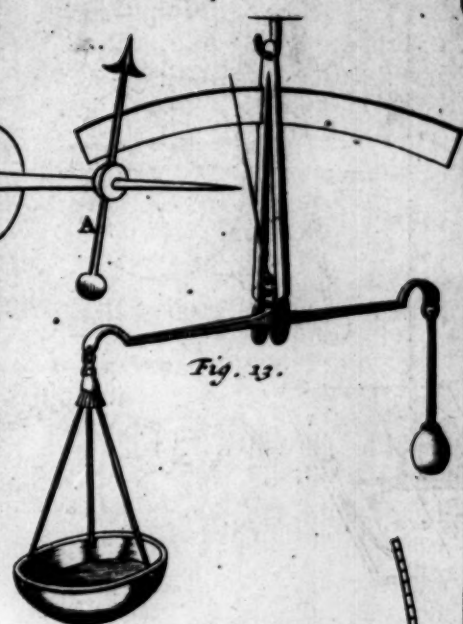
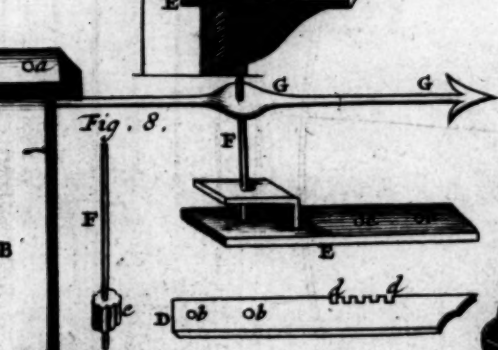
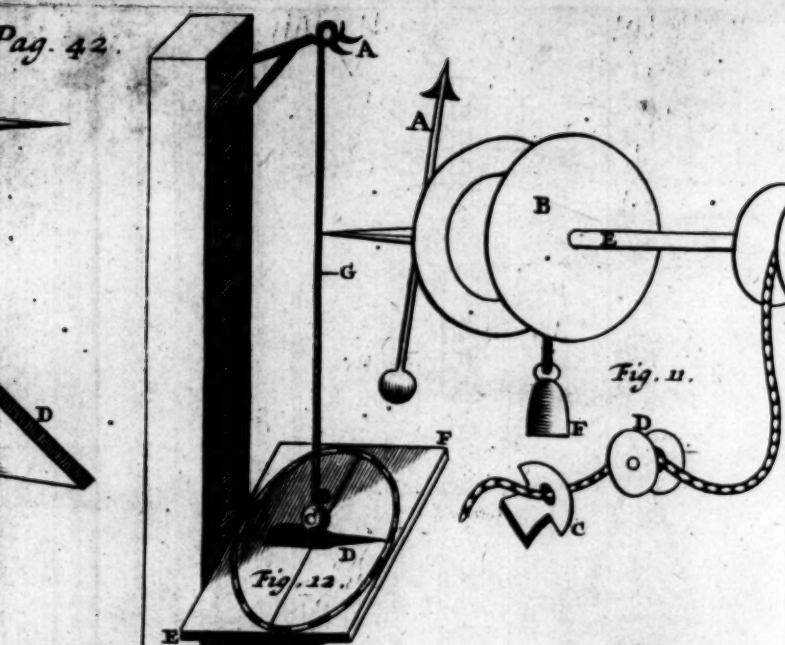


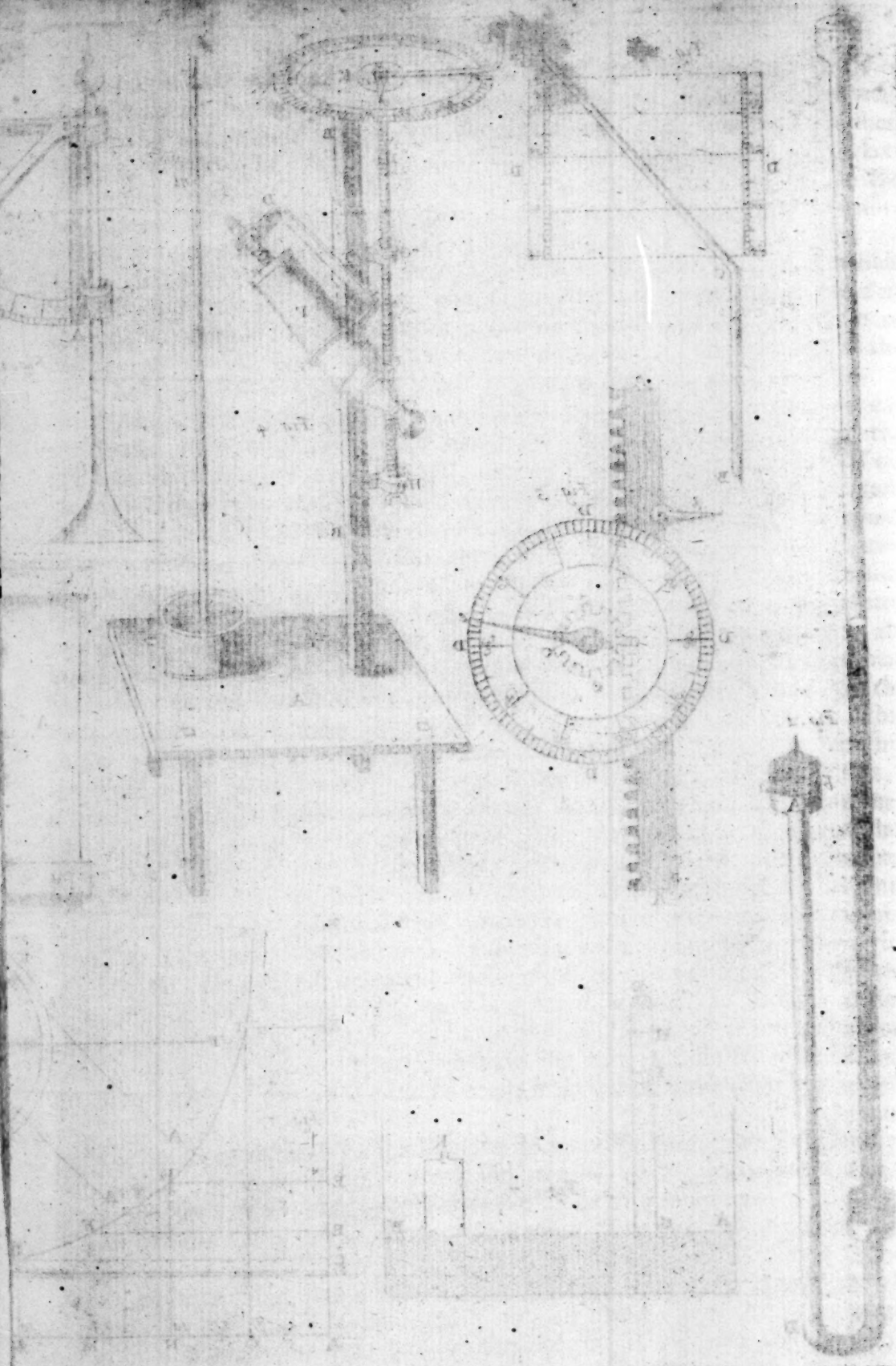
Fig. 5.



Anoth
Mr.
Goult
p. 50
Fig. 1

To obli
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p. 44
Fig. 1

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p. 64



This Winter 187 $\frac{1}{2}$ now newly ended, I have kept an exact Account of Wind and Weather, being well provided with a *Barometer*, sealed *Thermometers*, *Hygrosopes*, &c. To transcribe my Journal here would be too tedious; let it suffice therefore to tell you, that it hath been a very fair and warm, or rather no Winter at all; that we have not had above five or six frosty Mornings this Winter, and none that lasted longer than till Noon; that we had Snow but thrice, the first before *Christmas*, the second upon the eleventh, and the third upon the seventeenth of *January*: This last, which was the longest Snow we had this Winter, continued not forty eight Hours, but thawed. All this Winter we never had two Days of Rain together, nor above two or three that could be well called Rainy Days. *March* 14, we had a Shower of Rain and Hail together; the Wind being South-west and calm. The Mercury in my *Barometer* (which is very slender, but carefully fill'd, and conveniently placed) is for the most Part about 29 $\frac{1}{4}$ Inches high, above the Surface of the stagnant Quick-silver; but yet doth very sensibly and frequently vary its Height, according to the Difference of the Atmosphere's Gravity: *Jan.* 17, (which was the Day it last snowed here) the Mercury was subsided to 28 $\frac{2}{3}$ Inches. The next Day it was 28 $\frac{6}{10}$, being towards Night somewhat blustering, and the Snow thawed. *Jan.* 19 being fair but very foggy, the Mercury was at 28 $\frac{1}{10}$, which is the lowest Station it was ever at yet with me; the Wind was Westerly and calm. The next Day it was up again to 29, and afterwards higher. *Feb.* 15, in the Morning, being cloudy, the Wind Westerly and blustering, the Mercury was at 29 $\frac{1}{10}$; and about eleven that Night, being fair, clear and calm, it was risen to 30 $\frac{1}{10}$ Inches. The next Day being still fair, calm, it was at 30 $\frac{1}{10}$ Inches; which is the utmost Height I have yet seen it at. Next Day it fell a little beneath 30, and kept, as before, for the most Part about 29 $\frac{1}{10}$ or $\frac{4}{10}$, to this present; only on the eleventh of *March* it was at 30 again. Though it be observed, that frosty and snowy Winters make early Springs, and for as little as we have had of either this Winter, yet there hath not within the Memory of any now living happened a forwarder Spring in *Ireland*; since this Place could produce some Store of ripe *Cherries* in the midst of *April*. The Wind keeps for the most Part here between the North-west and the South, seldom at East, and yet seldomer at North or North-east, inso-much that many here don't scruple to affirm, that for at least $\frac{3}{4}$ of the Year, the Wind is Westerly; and we have sometimes known Passengers wait at *Chester* and *Holy-head* no less than three Months for a fair Wind to come hither.

*Observations
of the Wea-
ther in Ire-
land, 1675.
ib. p. 649.*

XIX. I fixed a round Tunnel of twelve Inches Diameter to a Leaden Pipe, which could admit of no Water, but what came through the Tunnel, by reason of a Part solder'd to the Tunnel it self, which went over the Pipe, and served also to fix it to it, as well as to keep out any wet that in stormy Weather might beat against the under Part of the Tunnel; which was so placed, that there was no building near it that would give occasion to suspect that it did not receive its due Proportion of Rain that fell through the Pipe some nine Yards perpendicularly, and then was bent into a Win-
dow

*To measure
the Quantity
of falling
Rain; by Mr.
Townley, n.
208. p. 51.*

dow near my Chamber, under which convenient Vessels were placed to receive what fell into the Tunnel; which I measured by a Cylindrical Glass, at a certain Mark containing just a Pound or twelve Ounces *Troy*, and had Marks for smaller Parts also. By the Help of this Cylindrical Glass I thus kept my Account of what Rain fell, and generally twice or thrice a Day; when I took several other Observations, both of the *Thermometer*, *Barometer*, Winds, &c. what Rain I found in the Receivers, if not more than made what was left in the Cylindrical Glass a full Pound, I again left in it; but if there was more than that Quantity, I filled it just to the Pound Mark, which I threw away, and did the like with the remaining Water as often as it would allow, still keeping an Account chiefly of the Pounds thrown away, and noting also the Parts of a Pound remaining in the Glass; by the Help of which latter, and the Parts remaining at any time before, by numbering the Pounds and subtracting the Parts at the End, (for Example, of one Month,) from the Pounds thrown away, and the Parts remaining at the End of another, I find the Quantity of Rain fall'n betwixt these two Times, and that so as to assure me, that I erred no more in the Quantity of Rain of another Year, than by the Mistake in the Differences of the Parts of a Pound in the first and last Observation; whereas should I still write down the Rain that falls between two Observations, I might be subject to make as great a Mistake in every one of them, and consequently be much more uncertain of the Quantity of Rain fall'n in many of those added together: Besides, this Addition is longer in performing and giving the Quantity sought, than the Method I make use of. I have added these Particulars to shew you how little Trouble there is in this Task.

Observations of the Rain, falling Monthly for 15 Years; by Mr. Townley, ib. p. 53.

	1677	78	79	80	81	82	83	84	85	86	Sum.
Jan.	472	371	43	512	53	986	238	32	110	472	3289
Feb.	270	371	161	492	363	135	245	483	42	20	2582
March	245	250	202	413	235	237	305	87	185	572	2731
April	325	170	92	222	57	308	402	370	380	305	2631
May	313	581	105	188	69	315	353	97	201	437	2659
June	516	257	298	342	397	517	468	192	410	473	3870
July	351	339	350	302	292	482	412	313	497	188	3526
Aug.	485	145	835	502	425	385	582	338	398	870	4965
Septemb.	223	527	553	146	607	293	152	199	163	572	3435
October	333	644	616	570	170	427	339	425	325	293	4133
Novem.	432	555	127	479	235	525	192	579	522	709	4355
Decemb.	400	57	439	269	423	456	37	299	548	132	3051
Sum.	4365	4267	3821	4428	3326	5066	3716	3414	3781	5043	41227

	1689	90	91	92	93	Sum.
Jan.	333	707	197	54	218	1509
Febr.	393	171	112	168	78	922
March	875	145	476	347	298	2136
April	468	78	386	498	539	1969
May	182	244	300	330	93	1149
June	302	179	412	416	181	1490
July	120	218	285	448	112	1183
August	222	402	193	198	668	1683
Septem.	442	403	215	605	641	2306
Octob.	740	765	165	273	514	2457
Novem.	415	717	230	148	627	2137
Decem.	368	262	169	892	261	1952
Sum.	4860	4291	3140	4372	4230	20893

All I have yet learnt from these Observations, as to the main Point, is, that here we have almost just twice the Quantity of Rain that falls at *Paris*. This County, (of *Lancaster*) and particularly that Part of it (about *Townley*) where I live, being generally esteemed to have much more Rain than other Parts, and in a greater Proportion than I thought reasonable to be allowed; however it be, yet by what I have sent you, 'twould be unjust, without farther Observations of the like Nature in other Parts, that all *England* should be esteemed to abound as much in Rain as these Parts do, where, by reason of the very high Grounds in *Yorkshire*, and the Eastern Parts of *Lancashire*, the Clouds driven hither by the S. and S. W. the general Winds in this Part of the World, are oftner stop't and broken, and fall upon us, than such as come by an E. or S. E. Wind, which, broken by the Hills, are generally spent there, and then little affect us; and this is the Reason that *Lancashire* has often considerably more Rain than *Yorkshire*.

In the Table I have sent you the Pounds and Parts are doubled, and these I have rather sent you than those of the whole Pounds; since the same gives both the Quantity of half Pounds, and the Height in Inches, according to the general Way of estimating the Quantity of Rain, only with this Difference, that for the half Pounds, only the last Figure is a Decimal Fraction, and the other the Number of the half Pounds; and for the Height, the two last Figures denote the decimal Fraction of an Inch, and the Remainder the Height in Inches, so near the Truth, that they only fall short of it 1 Inch in 200, which Defect is easily supplied. To this I need only add, that the Numbers on the Right-hand are the Sums of all those in the same Line that is in the first Part of several Numbers for ten Years; so that the last of them shews the Sum both of the half Pounds that have fallen during that Space of Time, and the Height the Water would have been raised in that Time also. To this

this I shall only add one Example: The Sum of all the Rain in the ten first Years is 41227, and therefore according to what hath been said, 4122,7 is the Number of half Pounds that fell in the Compass of the Tunnel during those ten Years; and 412,27 the Height it would have raised the Water during that Time. But if you desire to be more critical, if you add 206 its two hundredth Part, you will have 414,33 for the true Height, and 41,433 for the mean Height, by those ten Year's Observation; and 412,27 for the mean Quantity of half Pounds. By the same Method you will have the Means for the other five, viz. of Height 41,78, and 417,8 for the mean Number of half Pounds, which Means do strangely agree, and both considered, do give for the Mean by all the fifteen Years 41,516 Inches in Height, which is about $\frac{1}{2}$ of an Inch more than double to that raised by the Water at *Paris*, which is set down in the *Memoirs for the Ingenious*, for *February* last, is stated about $19\frac{1}{2}$ French Inches, which make 21 English.

My Way of Gauging by Weight is grounded upon 22,7368 Cubical Inches of Rain-water, being equal in Weight to one Pound, or 12 Ounces *Troy*; so that dividing any Superficies in Inches of a Vessel, for receiving the Rain-water, by the before-mentioned Number, it will give you the Pounds and Parts that will raise the Water upon that Superficies, with upright Sides, just an Inch: And thus I found that 4,974 Pounds would fill a Cylinder equal at the Bottom to my Tunnel and one Inch high, which you see is very near 5 Pound, which you will also find will only raise the Cylinder higher by $\frac{1}{300}$ Part.

*A History of
the Weather
at Oxford,
1684; by
Dr. Plot, n.
169. p. 930.
Fig. 27.*

XX. I here give you the Observations of a full Year, made by Order of the *Philosophical Society* at *Oxford*, not only of the Rise and Fall of the Quick-silver, (mark'd by the wandring prickt Line, after *Dr. Lister's* Method) and the Weather; but also how the Wind stood each Day. If the same Observations were made in many foreign and remote Parts at the same Time, we should be enabled with some Grounds to examine, not only the Coastings, Breadth and Bounds of the Winds themselves, but of the Weather they bring with them; and probably in Time thereby learn to be forewarned certainly of divers Emergencies (such as Heats, Colds, Dearth, Plagues, and other epidemical Distempers) which are now unaccountable to us; and by their Causes be instructed for Prevention, or Remedies. Thence too in Time we may hope to be informed how far the Positions of the Planets, in Relation to one another, and to the fixed Stars, are concerned in the Alterations of the Weather, and in bringing and preventing Diseases, or other Calamities; for by this means it is, doubtless, that the Learned *Dr. Goad* of *London*, has arriv'd to that Pitch of Knowledge he already has in predicting Weather. This, no Question, was the Opinion of the industrious *Walter Merle*, Fellow of *Merton College*, who thus observed the Weather here at *Oxford* every Day of the Month seven Years together, viz. from *January* 1337 to *January* 1344; the MS. Copy of which Observations are yet remaining in the *Bodleian Library*. And doubtless it was some such Consideration as this, that moved *Erasmus Bartholin* to make Observations of the Weather every Day through the whole Year 1671, which are printed *inter Alia Medica Tho. Bartholini*.

Weather,

D.	<i>Weather, Jan. 168$\frac{1}{4}$.</i>	D.	<i>Winds.</i>	<i>Weather, Feb. 168$\frac{1}{4}$.</i>
1	Hard Frost, and fair.	1	N. E.	Frost and fair.
2	Frosty, but yielding a little towards Night.	2	N. E.	Frost, a little Thaw at Night.
3	Rimy Frost.	3	Due E.	Frost and fair.
4	Hard Frost and fair.	4	Due S.	Close Weather, and a little Thaw and Snow at Night.
5	Hard Frost and fair.			
6	Hard Frost and fair.			
7	Hard Frost, but a little yielding at Night.	5	S. W.	Thawing Weather, Wind and Rain at Night.
8	Rimy Frost Morn, fair all Day, windy Night.	6	Due W.	Fair, clear Weather.
9	Frost, but Snow at Night.	7	Due W.	Close, thawing, rainy Weather.
10	Cold raw Weather toward Noon, Rain toward Night.	8	N. by W.	Close Weather.
11	Moist, thawing Weather.	9	Due S.	Fair in the Morn, Rain and Snow at Night.
12	Close, thawing Weather.	10	Due S.	Close, wet Weather.
13	Moist, close Weather, a small Frost at Night.	11	Due S.	Fair Morning, wet at Night, and windy.
14	Close, frosty Weather.	12	S. S. W.	Close Morning, fair at Night.
15	Close, frosty Weather.			
16	Close, frosty Weather, at Night windy.	13	N. by W.	Close Morn, fair at Night.
17	Frost, at Night Snow.	14	W. and N.	Rainy Morn, fair at Night.
18	Snow and Wind.	15	N. W.	Fair Weather.
19	Close, sharp Weather.	16	Due S.	Rainy Morning, close at Night.
20	Close, <i>at supra</i> , but a little yielding at Night.	17	S. W.	Close, moist Weather.
21	Mild Frost and fair.	18	S. W.	Rainy and Wind.
22	Hard Frost, Snow at Night a little.	19	Due W.	Moist Morning, fair Afternoon.
23	Hard Frost.	20	W. S. W.	Open, fair Weather.
24	Hard Frost and fair.	21	S. W.	Close Weather, windy.
25	Hard Frost and Snow.	22	W. S. W.	Close, rainy Weather.
26	Frost, a little Snow.	23	Due W.	Wet Morn, fair Afternoon.
27	Frost, a little Thaw about Noon.	24	W. by S.	Fair Morning, close Evening.
28	Frost and fair.			
29	Frost, a small Thaw all the Afternoon.	25	S. W.	Fair Morning, close Evening.
30	Hard Frost and fair.	26	S. W.	Wet Morning, close Evening.
31	Frost and fair.	27	S. E.	Wet Morn, fair Evening.
		28	N. E.	Close, frosty Weather.
		29	E. by S.	Frosty, clear Weather.
				<i>Wind.</i>

<i>D.</i>	<i>Wind.</i>	<i>Weather, March 1684.</i>	<i>D.</i>	<i>Wind.</i>	<i>Weather, April 1684.</i>
1	<i>S. E.</i>	Cloſe, froſty, cold Weather.	1	<i>N. & W.</i>	Fair, ſun-ſhine Weather.
2	<i>N. E.</i>	Cloſe, cold Weather.	2	<i>W. by N.</i>	Rain in the Morning, fair Evening.
3	<i>N. by W.</i>	Cloſe, froſty Weather.	3	<i>S. by W.</i>	Fair Morning, Wind and Rain at Night.
4	<i>N. by W.</i>	Cloſe, cold Weather.	4	<i>S. by W.</i>	Cloſe, moiſt Weather.
5	<i>Due N.</i>	Cloſe Morning, Snowy Evening.	5	<i>S. W.</i>	Rainy Weather.
6	<i>N. E.</i>	Cloſe, cold Weather.	6	<i>Due W.</i>	Fair Morning, wet at Night.
7	<i>N. N. E.</i>	Froſt, fair and windy.	7	<i>Due W.</i>	Fair Weather.
8	<i>N. N. E.</i>	Froſt, cloſe and windy.	8	<i>S. W.</i>	Cloſe Weather.
9	<i>E. by N.</i>	Froſt and high Winds.	9	<i>N. W. & N.</i>	Cloſe Weather, but fair.
10	<i>E. N. E.</i>	Cloſe, froſty, cold Weather.	10	<i>N. E.</i>	Cloſe, fair Weather.
11	<i>N. by W.</i>	Froſt and fair, cloſe at Night.	11	<i>Due E.</i>	Rain and Wind moderate.
12	<i>Due N.</i>	Froſty, ſnowy, windy Weather.	12	<i>N. & W.</i>	Cloſe, cold Weather.
13	<i>N. by E.</i>	Froſty Morn, fair Night.	13	<i>N. by E.</i>	Fair, ſun-ſhine Weather.
14	<i>N. by E.</i>	Froſt, Snow and Wind.	14	<i>E. N. E.</i>	Fair Morning, cloſe Evening.
15	<i>N. N. E.</i>	Snow and Wind.	15	<i>N. E. by E.</i>	Cloſe, cold Weather.
16	<i>N. N. E.</i>	Snow and Rain.	16	<i>E. by N.</i>	Cloſe, cold Weather.
17	<i>N. by E.</i>	Cloſe, moiſt Weather.	17	<i>E. by N.</i>	Cloſe, cold Weather.
18	<i>W. by N.</i>	Cloſe Morn, fair Night.	18	<i>S. & W.</i>	Variable, dry Weather.
19	<i>N. E.</i>	Cold, changeable Weather.	19	<i>Due S.</i>	Moiſt Morning, wet Night.
20	<i>N. N. W.</i>	Snow, and cold, high Winds.	20	<i>S. E. & S. W.</i>	Cloſe, warm Weather.
21	<i>N. E.</i>	Cloſe, but fair Weather.	21	<i>S. E.</i>	Fair, ſun-ſhine Weather.
22	<i>N. E.</i>	Fair Weather, but cold.	22	<i>S. & N. & E.</i>	Fair Morning, inclinable to Rain at Night.
23	<i>E. by N.</i>	Cold, fair Weather.	23	<i>S. W.</i>	Rainy Morning, fair Evening.
24	<i>E. by N.</i>	Cold, fair Weather.	24	<i>S. W.</i>	Fair, ſun-ſhine Weather.
25	<i>E. by N.</i>	Cold, fair Weather.	25	<i>S. W.</i>	Fair, ſun-ſhine Weather.
26	<i>Due E.</i>	Cold, fair Weather.	26	<i>Due S.</i>	Cloſe, dry Weather.
27	<i>Due E.</i>	Cold, cloſe Weather.	27	<i>S. W.</i>	Fair, ſun-ſhine Weather.
28	<i>S. by W.</i>	Warm, moiſt Weather.	28	<i>S. W.</i>	Cloſe, dry Weather.
29	<i>S. by W.</i>	Wind and Rain.	29	<i>S. W.</i>	Cloſe, dry Weather.
30	<i>S. by W.</i>	Cloſe, fair Weather.	30	<i>Due S.</i>	Rainy Morning, fair Evening.
31	<i>Due S.</i>	Fair, calm Weather.			

Wind.

D.	Wind.	Weather, May, 1684.	D.	Wind.	Weather, June, 1684.
1	S. S. W.	Variable Weather.	1	S. W.	Clofe Morning, fair Even- ing.
2	Due W.	Fair Weather.	2	Due W.	Clofe Morning, rainy E- vening.
3	S. S. W.	Clofe, fair Weather.	3	Due W.	Fair Morning, rainy Eve- ning.
4	W. S. W.	Clofe, fair Weather.	4	Due W.	Clofe, fair Weather.
5	W. S. W.	Moist Morning, fair Eve- ning.	5	Due W.	Clofe, fair Weather.
6	W. S. W.	Clofe, fair Weather.	6	Due W.	Clofe, fair Weather.
7	W. S. W.	Clofe Morning, Rain at Night.	7	W. & N.	Clofe, fair Weather.
8	S. S. E. S. & w	Fair, warm Weather.	8	Due N.	Fair Sun-shine Weather.
9	N. W.	Clofe, fair Weather.	9	Due N.	Clofe, fair Weather.
10	Due W.	Clofe, fair Weather.	10	N. E.	Fair Sun-shine Weather.
11	Due W.	Clofe, fair Weather.	11	Due E.	Fair Sun-shine Weather.
12	Due W.	Misty Morning, fair Eve- ning.	12	Due E.	Fair Sun-shine Weather.
13	S. & W.	Wet Morning, fair Eve- ning.	13	E. S. E.	Fair Sun-shine Weather.
14	S. W.	Clofe weather, some Rain.	14	E. S. E.	Fair Sun-shine Weather.
15	Due N.	Clofe, fair Weather, some Wind.	15	E. S. E.	Fair Sun-shine dry Wea- ther.
16	N. N. E.	Windy Morning, clofe Evening.	16	E. S. E.	Fair Sun-shine hot Wea- ther.
17	N. E.	Clofe, dry Weather.	17	E. S. E.	Fair Sun-shine hot Wea- ther.
18	N. E.	Clofe fair Weather.	18	E. by N.	Sun-shine Morning, clou- dy Evening.
19	N. E.	Fair Sun-shine Weather.	19	E. by n. S. f. w.	Sun-shine hot Weather.
20	E. by N.	Clofe, fair Weather, some Wind.	20	S. by W.	A little Rain, cloudy.
21	N. E.	Warm Morning, clofe Evening.	21	S. e. E. S. E.	Lowring, some Rain.
22	N. E.	Clofe, fair and windy.	22	N. E.	Fair, hot Weather.
23	N. E.	Clofe, fair and windy.	23	N. E.	Hot, a muddy Sky.
24	N. E.	Clofe Morning, fair Sun- shine Evening.	24	N. E.	Sun-shine, clear.
25	N. E.	Clofe, fair Weather.	25	N. E.	Sun-shine, fair Weather.
26	S. E.	Fair Sunshine Weather.	26	N. E.	Sun-shine, dry Weather.
27	N. E.	Clofe, fair Weather.	27	N. E. E.	Very dry.
28	E. by N.	Fair Sun-shine Weather.	28	E. S. E.	Hot, lowring Evening.
29	S. W.	Wind and Rain.	29	S. S. W.	Sun-shine, clear.
30	Due W.	Clofe, fair Weather.	30	S. W.	Cloudy, cool.
	S. W.	Clofe Weather, a little Rain at Night.			

D.	Wind.	Weather, July, 1684.	D.	Wind.	Weather, August 1684.
1	S. w. W. n. w.	Somewhat cloudy.	1	N.	Warm Sun-shine Weath.
2	W.	A little Rain, fair.	2	W.	Cool, fair Weather.
3	S. W.	Fair, but cloudy.	3	S. W.	Warm, fair Weather.
4	S. W. W.	Close, some Rain.	4	Due S.	Hot Sun-shine Weather.
5	S. W.	Sun-shine Morning, gloomy Evening.	5	S. W. by S.	Hot Sun-shine Weather.
6	S. W.	Close.	6	S. W. by S.	Warm Sun-shine Weather.
7	W. S. W.	Cool, close.	7	Due S.	Rainy Morning, fair Evening.
8	S. W.	Hazy, some Rain.	8	Due S.	Close, fair Weather.
9	W. N. W.	Some Rain, clear.	9	Due W.	Fair Sun-shine Weather.
10	N. W.	Clear Sun-shine.	10	Due N.	Fair Sun-shine Weather.
11	S. W.	Rain.	11	S. W.	Fair Morn, inclinable to Rain at Night.
12	W.	Some Rain, fair Evening.	12	Due W.	Rainy Morning; the same in the Evening.
13	W.	A Shower or two.	13	Due W.	Fair Sun-shine Weather.
14	W. S. W.	Cool, close Weather.	14	Due W.	Fair Sun-shine Weather.
15	W. S. W.	Rain.	15	W.	Fair Sun-shine Weather.
16	W.	Cool, close Weather.	16	W. N.	A Shower, Sun-shine Weather.
17	W.	Cool, close Weather.	17	N. W.	Sun-shine Morning, cloudy Evening.
18	N. W.	Fair, sun-shine Weather.	18	N. n. w. N.	A muddy Sky in the Morning, Sun-shine Evening.
19	W. S. W.	Lowring, cool Weather.	19	N. S. W.	Fair Sun-shine Weather.
20	W. N. W.	Fair Sun-shine Weather.	20	S. S. W.	Hot Sun-shine Weather.
21	W.	Fair Sun-shine Weather.	21	S. S. W.	Hot Sun-shine Weather.
22	W.	Hot Sun-shine Weather.	22	S. W.	Fair Sun-shine Weather.
23	W. S.	Hot Sun-shine Weather.	23	S. W.	Hot Sun-shine Weather.
24	S. E.	Hot Sun-shine Weather.	24	S. W.	Hot Sun-shine Weather.
25	E. by S.	Hot Sun-shine Weather.	25	N.	Rain all Day.
26	E. by S.	Hot, a little Rain towards Night.	26	S. W.	Rain at Night.
27	W. N.	Hot Sun-shine Weather.	27	N. W.	Close, some Rain.
28	W.	Hot, Thunder, Rain.	28	S. W.	Close Weather.
29	N. N. E.	Cloudy, some Rain.	29	S. S. W.	Close, Rain at Night.
30	N. N. E.	Fair Sun-shine Weather.	30	Due S.	Variable Weather.
31	N. E.	Hot Sun-shine Weather.	31	S. by E.	Close, some Rain.

Wind.

D.	Wind.	Weather, Septemb. 1684.	D.	Wind.	Weather, October 1684.
1	S. by E.	Clofe, some Rain.	1	N. W.	Moist Weather, some Rain.
2	Due S.	Clofe, some Rain.	2	W. by S.	Clofe Weather, but fair.
3	S. E. W.	Clofe, Rain, Thunder.	3	S. W.	Clofe Morning, fair Evening.
4	S. E. S. W.	Clofe, some Rain.	4	S. by W.	Clofe all Day, Rain at Night.
5	Due E.	Clofe Morning, rainy Afternoon.	5	W. N. W.	Rainy Morning, fair Evening.
6	S. S. E.	Clofe, some Rain.	6	Due W.	Rainy, windy Weather.
7	N. W.	Fair Sun-shine Weather, Rain at Night.	7	S. by W.	Rain all Day.
8	N. W.	Fair, clofe, dry Weather.	8	N. N. W.	Rainy Morning, fair Evening.
9	N. W.	Sun-shine Morning, clofe Evening.	9	N. N. n. w.	Clofe, fair Weather.
10	N. W. N. E.	Sun-shine Morning, some Rain.	10	N. W.	Fair Weather.
11	W. by N.	Fair Morning, clofe Evening.	11	S. W.	Windy, rainy Morning, fair Evening.
12	N. W. N.	Fair Morning, some Rain at Night.	12	S. S. W.	Clofe, and some Wind.
13	N. N. W.	Rainy Weather.	13	S. S. W.	Clofe, some Rain.
14	Due N.	Fair Sun-shine Weather.	14	S. S. W.	Rain and Wind.
15	N. by E.	Fair Sun-shine Weather.	15	S. by E.	Wind and Rain.
16	Due N.	Clofe, fair Weather.	16	S. S. W.	Fair Sun-shine Weather.
17	N. W.	Clofe and windy.	17	S. W.	Fair Sun-shine Weather.
18	Due N.	Fair Morning, some Rain, fair again.	18	W. by N.	Fair Weather.
19	Due N.	Fair Morning, clofe Evening.	19	N. W.	Clofe Morning, fair Sun-shine Evening.
20	Due S.	Fair Sun-shine Weather.	20	N. W.	Fair Weather.
21	S. b. E.	Fair Sun-shine Weather.	21	Due W.	Fair Sun-shine Weather.
22	Due S.	Fair Sun-shine Weather.	22	Due W.	Clofe, fair Weather.
23	S. by W.	Fair Morning, clofe Evening.	23	Due W.	Fair Morning, Wind and Rain at Night.
24	Due W.	Fair Sun-shine Weather.	24	N. W.	Wind, Snow, and Rain.
25	S. by W.	Changeable Weather.	25	N. W.	Clofe, cold and windy.
26	Due S.	Changeable Weather.	26	N. W.	Fair, frosty Weather.
27	Due S.	Rainy Weather.	27	N. E.	Frost and Snow.
28	Due S.	Clofe, moist Weather.	28	S. W. N.	Frost and Snow.
29	S. W.	Clofe, moist Weather.	29	N. W.	Frosty, cold Weather.
30	N. W.	Clofe Morning, Sun-shine Evening.	30	N. W.	Snow and Wind.
			31	Due N.	Cold Thaw in the Morning, clear, frosty Evening.

D.	Wind.	Weather, Novemb. 1684.	D.	Wind.	Weather, Decemb. 1684.
1	S. by W. N.	Thaw, Snow, Frost.	1	N. N. E.	Frost, Sun-shine.
2	N. W. W.	Frosty Morning, Thaw Afternoon.	2	N.	Frost, Sun-shine.
3	S. by W. W.	Thawing weather all Day	3	W. S. W.	Snow, much small Rain.
4	N. W.	Close and windy.	4	S.	Cloudy, some Rain.
5	N. W.	Close and windy, little Frost.	5	S.	Warm, Sun-shine Wea- ther.
6	Due W.	Fair Weather, little Frost.	6	S. e. E. N. E.	Misty, thick, moist Air.
7	N. S.	Fair Morning, rainy Eve- ning.	7	E. N. E.	Frost, Sun-shine Wea- ther.
8	E. by S.	Small Rain all Day.	8	E. N. E.	Moist, cloudy Air.
9	S. E.	Misty, moist Weather.	9	E. N. E.	Moist, cloudy Air.
10	Due W.	Rainy, misty Weather.	10	E. N. E.	Thick, moist Air.
11	N. W.	Cloudy, moist Weather.	11	E. N. E.	Fair, but cloudy.
12	S. W.	Cloudy, moist Weather.	12	E. N. E.	Close.
13	S. W.	Cloud, some Sun-shine.	13	E. N. E.	A moist, close Air.
14	S. W.	Close Mist at Night.	14	E. S. E.	Frost, clear Sun-shine.
15	N. W.	Frosty Morning, close Evening.	15	E. W. S. W.	Frost, cloudy.
16	N. W.	Close Morning, clear frosty Evening.	16	N. W. N.	Frost, cloudy.
17	N. W. N.	Hard Frost and clear.	17	W.	Frost, cloudy, a little Snow.
18	N.	Hard Frost, Sun-shine.	18	N.	Frost, Sun-shine.
19	S.	Close, Snow, Rain.	19	W.	Thaw, cloudy.
20	S.	Much Rain.	20	N. N. W.	Rain, Hail, Snow.
21	W.	Warm Sun-shine weather.	21	W.	Frost, Sun-shine.
22	S.	Frost, Rain.	22	N.	Frost, Sun-shine.
23	S. W.	Fair, somewhat warm.	23	E.	Hard Frost, windy.
24	W. S. W.	Some Rain.	24	N. E.	Frost, Sun-shine.
25	W. N. W.	Close, fair.	25	N.	Frost, cloudy, much Snow.
26	W.	Fair, warm, close.	26	N.	Hard Frost, Sun-shine.
27	N. W.	Some Rain.	27	W.	Frost, Sun-shine.
28	N.	Cold, cloudy, Rain.	28	N. W.	Rain all Day.
29	N. E.	Fair, but cloudy.	29	N. W.	Frost, Rain at Night.
30	N.	Fair.	30	W. N. W.	Some Rain, fair Even- ing.
			31	E.	Fair, cloudy.

XXI. At *Cape Corse* in the Latitude of $4^{\circ} 49'$ N. *An.* 1686, Nov. 24 and 25, Clear and hot. 26, About two *a. m.* a Storm of Rain with Thunder for half an Hour. 27, At the same Hour, Rain which lasted somewhat longer. 28, About five *a. m.* some Rain, afterwards misty, and about ten extream hot. 29, About two *a. m.* a great Storm of Rain flacking often, but renewing again, it lasted about an Hour; the Day after clear.

Thence to Dec. 7, clear; then cloudy in the Morning, between twelve and one *p. m.* a Shower lasting about half an Hour: thence clear and hot. 10, A little Mist in the Morning, otherwise very clear and hot; so till 15.

15, And some Days after, somewhat thick, especially in the Morning. 19 and 20, We had a dry North and North-easterly Wind, call'd an *Hermitan*, and it overcame the *Sea Breeze*; found very ill for the Eyes, and most Men complained of a feverish Temper; it was parching, but rather colder than ordinary. 21, It ceased; a clear Air and very hot.

23, We had the *Hermitan* again, but the Morrow it ceased: Then and 25, some Clouds, but no Rain. Thence to 29, clear and hot. 29, The *Hermitan* returned, but did not continue. Thence Clouds sometimes, but no Rain till Jan. 2.

This Month we had three Funerals, one being sick of the Flux laid violent Hands upon himself, through Impatience of the Pain, the third Day. The second, upon the twenty fifth died convulsively, not having been sick above one Day. The third, Dec. 17, died of a Dropsy, which had succeeded a tedious Flux.

An. 1687, Jan. 2, About five *a. m.* Rain for half an Hour, between seven and nine an Hour, from half an Hour past nine to one *p. m.* the rest cloudy. 5, At two *a. m.* about half an Hour. 8, At one in the Morning about an Hour, the Days between somewhat cloudy: Thence to 12 extream hot.

12 and 14, Somewhat cloudy, otherwise the Heat continued. 17, At seven *p. m.* a *Tornado* for above half an Hour, and about twelve at Night another; but the Heat very little abated.

22, Between five and six *p. m.* began a *Tornado*, which lasted above an Hour very violent, with great Claps of Thunder and Lightning. Tank fill'd one Foot. 23, In the Morning a great Mist, after eight clear and extreme hot.

The latter End of *January*, and the Beginning of *February*, commonly misty in the Morning; after extream hot.

Feb. 10. Somewhat cloudy and cool, till then we were troubled with Coughs, for the most Part; about this Time they ceased. So the eleventh towards Night, Thunder afar off, and Expectation of a *Tornado*; but it fail'd. 12, Extream hot. 13, A stronger Wind than ordinary from Sea-ward. 14, Something like an *Hermitan*, but not from its usual Quarter; clear and hot till about two *p. m.* then cloudy, but no Rain. Thence to 22, extream hot and clear. From 22 to March 1, some flying Clouds without Rain; sultry hot and unwholsome.

24, Some Shew of a *Tornado*, but it pass'd away.

This Month we had two Funerals.

The

The Beginning of *March* as the latter End of *Feb.* 5, From six *a. m.* for an Hour and half a violent *Tornado*; the Day after cloudy. 6, Clear. 7, At Night Lightning and Clouds afar off; but nothing followed. Thence to the eleventh clear and hot.

11, About five *a. m.* a violent Rain for almost half an Hour. 12 and 13, Cloudy. 14, About four *a. m.* a gentle Shower, but lasted not long. 15, Between six and seven *a. m.* a few Drops, and Likelihood of more, but nothing followed; both Days cloudy. 16, Extream hot. 17, Somewhat cloudy. Thence to 20, extream hot.

20, Cloudy; about ten *a. m.* some few Drops. 21, Very hot. 22, In the Morning hot; about twelve a violent Rain for a Quarter of an Hour. 23, Clear. 24, About two *a. m.* Rain for about half an Hour; the Day after clear. Thence to *April* 3, clear and extream hot.

No Funeral.

April 3, At three *p. m.* a violent *Tornado*, but only some few Drops of Rain; at five *p. m.* a little Rain. 4, Cloudy by Fits, otherwise very hot. 5, Hot and clear. 6, In the Morning hot, about two *p. m.* cloudy; about three some Drops of Rain, in the Evening the Clouds dispersed. 7, Clear and hot, 8, Between twelve and one in the Morning a violent Rain for near an Hour; after two, one somewhat longer; the Day after there appear'd to have been much Rain; Tank fill'd two Foot and somewhat more. 9, About seven *a. m.* some Drops, cloudy all Day.

10, Cloudy, about eleven *a. m.* a small Mist. 11, Presently after Midnight it began to rain, and lasted till six *a. m.* a great Part of the Time very violently, it began with a strong *Tornado*; Tank above three Feet. The Day after some Clouds, otherwise extream hot. So also 12 and 13. 14, About five *a. m.* a Shower for half an Hour, between six and seven *p. m.* another of the same Continuance, the Day between extream hot. So 15, 16, A Shower for half an Hour; it began with a violent *Tornado*, the Rain not much, afterwards cloudy. 17 and 18, Clear. 19, Clear also, about seven *p. m.* a considerable Wind, and Drops of Rain.

20, Clear, but windy, 21, Between twelve and two moderate Rain for near an Hour. 22, About two *a. m.* moderate Rain almost an Hour; at eleven *p. m.* a short Shower and gentle; the Day between extream hot. 23, Cloudy, about ten *a. m.* some Drops. 24, Extream hot. 25, About one *a. m.* Rain for near an Hour; the Morning after hot; Afternoon cloudy; most Part of the Night Thunder and Lightning, but no Rain. 26, At seven *a. m.* strong Rain for half an Hour, after that a little Mist; Afternoon from twelve to three it rained unequally, but the most part moderate. 27, Extream hot. 28, About twelve somewhat cloudy, at three *p. m.* it began to rain, and lasted about an Hour and an half; after, cloudy and some Drops, in the Night a Shower or two. 29, Cloudy. Thence to *May* 6 sometimes cloudy; but for the most Part violent hot.

This Month we had three Funerals; one on the third of a Fever, another on the nineteenth of I know not what Pains in the Guts; another on the twenty fourth of the Flux.

The

The fifteenth, and some Days following, there settled upon the Castle Walls certain Swarms of winged Ants, a little bigger than Bees; they would bite very severely, and were blown up with Powder.

May 6, In the Morning a little cloudy, Afternoon some Wind, followed by gentle Rain, which lasted till three *p. m.* after, cloudy. 7, Hot. 8, Cloudy; about ten *a. m.* a gentle Shower for three Quarters of an Hour; about eight *p. m.* a very violent Storm of Wind and Rain, but it quickly grew moderate, and lasted in all not above half an Hour. 9, Clear. 10, About Noon a violent Shower for a Quarter of an Hour; after eight *p. m.* another as long, but not so violent; past nine another shorter.

11, Clear. 12, Clear; past nine *p. m.* a very violent *Tornado* with Rain, which lasted somewhat more than two Hours. 13, Between twelve and one in the Night a short Shower; about nine *a. m.* some Drops; so also in the Afternoon, but nothing considerable; cloudy all Day. 14, Cloudy; at nine *a. m.* a violent Rain for a Quarter of an Hour; after, gentle for above an Hour; about three *p. m.* some Drops. 15, About three *a. m.* Rain for half an Hour; between four and five, another; after, foggy and cloudy, with some few Drops; about seven *p. m.* a violent *Tornado* with Rain for near an Hour. 16, About four *a. m.* Rain for an Hour; after eight for a Quarter of an Hour; after six *p. m.* Rain and Wind, but both moderate, for half an Hour; past eight about as much. 17, About four *a. m.* a short Shower; after clear. 18, Clear. 19, Cloudy; about ten *a. m.* some Drops.

20, Cloudy; between eight and ten *a. m.* a Shower; first violent, after more moderate, till it ended in a kind of Mist; it lasted in all about an Hour and half; the Day after clear. 21 and 22, Clear. 23, In the Afternoon cloudy; about six *p. m.* some Drops; the Night after, a Shower not considerable. 24, Hot, about ten *p. m.* a little Shower. 25, Clear. 26, In the Night some little Rain. 27, Held up. 28, At nine *p. m.* a short Shower. 29, At five *a. m.* Rain till near seven; a little past seven till nine, after cloudy. 30, Cloudy; the Night after, some Rain. 31, About eight *a. m.* Rain for half an Hour; from nine till twelve it rained for the most part very violently; before one, another Shower for half an Hour; from a little after two till five, with very great Thunder.

One Funeral on the twenty fifth, after but three Days Sickness.

The Beginning of this Month we had an extraordinary Number of Toads, which after some time were not to be seen. The fourteenth we had winged Ants as before.

24, Was the first Corn, the Seed-time having been the middle of *March*.

June 1, About four *a. m.* Rain for an Hour; past one *p. m.* for half an Hour; the rest cloudy and misty. 2, From two *a. m.* till five continual Rain, 'tis said there was some before; from nine *a. m.* till half an Hour past six *p. m.* continual Rain, sometimes very fierce; from half an Hour past nine at Night, Rain till past ten. 3, From six to a little past seven *a. m.* a very gentle Rain, from thence till one *p. m.* most commonly very fierce; thence for a little while more moderate; but it rained hard again till six *p. m.* then it dropped but slowly, and so continued till about seven; in the Night some little

little Rain. 4, About eight *a. m.* some Drops, thence clear. 6 and 7, Clear, except some few flying Clouds. 8, After three *a. m.* gentle Rain for near an Hour; then cloudy, and some Drops, after ten *p. m.* a Shower. 9, At five *a. m.* a gentle Shower, lasted till past seven; thence a very violent Rain till almost nine; some Drops after that; about three *p. m.* it began, and rained till past ten somewhat moderately. 10, Clear and hot.

11, Cloudy; about eight *p. m.* a few Drops. 12, From about two *a. m.* till near five, Rain, but not violent; a little before six a furious Storm of Rain, but little Wind, it lasted till half an Hour past seven. About three *p. m.* a moderate Rain till a little past four; and from thence to six, somewhat more than a Mist, the Night after it rained a little. 13, Cloudy, in the Afternoon it drop'd a little. 14, About eight *a. m.* a few Drops. 15, Somewhat cloudy. 16, Extreame hot, towards Night cloudy, about five *p. m.* a violent Shower for half an hour, from a little before eight till past ten it rained continually. 17, From four *a. m.* till almost six, gentle Rain, so from a little past six till past seven, thence till past three *p. m.* cloudy, and now and then some Drops, then a violent Shower for half a Quarter of an Hour; half an Hour after four it rained again, and continued till past ten, for the most part very furiously; with some little Intermission it rained all Night. 18, At three *a. m.* it rained very fiercely; about half an Hour after six it held up, but cloudy still; from eight *a. m.* till past three *p. m.* it rained, but moderately; then it held up a little, but rained after till past six, all Day cloudy, and at Night a great Fog. 19, About nine *a. m.* some Drops; from one till past three *p. m.* very gentle Rain.

Thence to the first of July foggy Morning and Evening, sometimes hot, but for the most part cloudy, and more temperate than could be expected from the Climate.

Two Funerals, one the ninth of an Asthma; the other the twenty first of a Fever.

We saw some sorts of Insects not usual here, whether monstrous or not I cannot tell. The most notable, a kind of Spider about the Bigness of a Beetle, the Form nearest of a Crab-Fish, with an odd kind of Orifice visible in the Belly, whence the Web proceeded.

July 1, Extreame hot. 2, Foggy in the Morning; about nine *a. m.* a few Drops; after, clear. 3, In the Morning a great Fog; about nine *a. m.* it rained small Rain for near an Hour; towards Night more foggy than ever before; about six *p. m.* small Rain for a little time, from eight till past nine somewhat more brisk Rain, after that it cleared up. 4, From nine *a. m.* to three *p. m.* small Rain, the rest foggy; between ten and eleven *p. m.* some Rain. 5, From two *a. m.* till past eight constant Rain, sometimes very fierce, sometimes moderate, about ten *a. m.* some Rain; between two and three *p. m.* it began to rain, but continued not long; from eight *p. m.* to ten, Rain. 6, From about two *a. m.* to six, Rain; after, fair. 7, Foggy and cloudy, between seven and eight *a. m.* some Drops. 8, Foggy in the Morning, otherwise clear and hot. 9, About one *a. m.* a smart Shower; between three and five, some more Rain. The Day after foggy. 10, Very dull and cloudy; from three *p. m.* till Night, a very great Mist. 11, Tole-

11, Tolerably clear, and very hot, yet somewhat foggy Morning and Evening. 12, Cloudy; thence to 15 in the Morning and Evening foggy, else very hot. 15, Cloudy; about ten *a. m.* some Drops; from half an Hour past two till four, moderate Rain; about seven, some Drops; cloudy, several times it dropped a little, but nothing considerable. 17, A little before Day a short Shower; after, cloudy; thence to 20, foggy Morning and Evening, and the most part cloudy.

20, Very clear all Day, and extream hot. 21, Not foggy at all; yet somewhat cloudy, but about Mid-day it cleared up. 22 and 23, Very clear and extream hot. 24, Cloudy in the Morning; after as the two last. 25, Cloudy, but not misty nor foggy; sultry hot. 26, In the Morning cloudy; after, extream hot. 27, Hot and clear. 28, Thin Clouds, through which the Sun shone very hot. 29 and 30, Cloudy. 31, About three *a. m.* two short Storms of Rain, the Day after clear and hot.

Two Funerals; one the seventeenth drowned, the other the twenty first of a Fever.

Aug. 1 to 5, Clear, for the most part in the Mornings cloudy; but without Fogs, sometimes very hot. 5, About five *a. m.* a Shower near an Hour long, about seven another for half an Hour; till ten, some small Rain; thence cloudy till one, about seven *p. m.* a few Drops. 6, Cloudy all Day, sometimes it dropp'd a little. 7, About two *a. m.* violent Rain with Wind for above half an Hour; the Day after, cloudy. 8 and 9, Cloudy and foggy. 10, More foggy than ordinary; about ten *a. m.* a great Mist, or small Rain for the most part of the Day after.

11, Foggy, as the former, and misty; between eight and nine *a. m.* a Shower of small Rain; Afternoon, clear. 12, Small Rain in the Morning; after, as 11. 13, Clear and hot, the *Land Breeze* very strong. 14, Cloudy all Day, the *Land Breeze* turn'd to a kind of *Hermitan*, but not troublesome, nor continued beyond this Day. 15, Cloudy, several Times very misty, and some small Rain. 16, Cloudy, but no Mist; Afternoon, clear: Thence to 22, Clear and hot; but the Nights colder than at other Times.

22, At six, *p. m.* Cloudy, a Wind *Tornado*, but moderate, with some Drops of Rain very large. 23, Clear and hot. 24, Cloudy and misty at first; about ten *a. m.* clear and hot. 25, Clear and hot. 26, Very foggy, Morning and Evening; for the rest, hot. 27, From five to ten *a. m.* it rained smartly; thence cloudy; about two *p. m.* it cleared up for a while; about nine *p. m.* a sharp Rain for half an Hour; 28, Between twelve and three *a. m.* it rained about two Hours; about seven some few Drops; after, cloudy; in the Middle of the Day it cleared a little, but quickly overcast again. 29, In the Night some Rain; at seven, *a. m.* Rain for half an Hour; till past twelve a very thick Mist; about three *p. m.* clear; at Night a very thick Mist. To the End cloudy and misty.

Three Funerals; 6, one of a Fever; 7, another of a Consumption; 29, a third of a Fever.

Sept. 1 and 2, as the last. 3, Some few Drops: Thence to 8, cloudy also and misty. 8, About six *p. m.* some small Rain; between eight and ten *p. m.* for an
Vol. II. I Hour

Hour pretty brisk Rain. 9, In the Morning cloudy and misty. 10, About ten *p. m.* a little Rain.

11, Extream hot and clear; in the Night considerable Rain for several Hours. 12, About ten *a. m.* some small Rain, the Morning very foggy, Afternoon clear. 13, Clear and hot. 14 and 15, In the Morning extream cloudy, and some Drops of Rain. 16, Clear and extream hot. 17, Moderate, about seven *p. m.* some Drops; at Night also some Rain, not considerable. 18, Cloudy; in the Morning about twelve, some Drops; all this Week, Morning and Evening, foggy and thick. 19, 20, 21, Extream hot; the Fogs ceased.

22, About one *a. m.* some Rain; the Day after cloudy. 23, 24, 25. In the Morning cloudy; after, very hot. 26, At Night also somewhat misty, with many Flashes of Lightning, but no Thunder. The like Flashes most Nights to the End of the Month, also often cloudy; at other Times extream hot.

Two Funerals; one the nineteenth of a Fever; the other the twenty sixth, whose Disease I do not know.

October 1, About three *a. m.* a very fierce Rain for near an Hour, milder towards the End; the Day after some flying Clouds. 2, About four, *a. m.* a little Rain, the Day after as before; from eight *p. m.* till ten, moderate Rain. 3, Cloudy; about ten *a. m.* Rain for somewhat more than an Hour. 4, Cloudy, between eight and ten *p. m.* a very smart Rain for above an Hour. 5, About nine *a. m.* a little Shower. 6, About five, *a. m.* a little Shower; another past six: The Day after, and the seventh, extream hot. 8, Hot in the Morning; Afternoon a Shew of a *Tornado*, with Thunder, and a considerable Wind, but no Rain.

Thence to 16, some flying Clouds, but generally hot. 16, About four *p. m.* a little Rain, the Sun shining then, and the whole Day, very hot; about eight *p. m.* a very strong *Tornado*, Wind and Rain for about half an Hour, afterward the Rain continued, but more moderate, for near two Hours. 17, Clear and hot. 18, So too, except that about three *p. m.* there was a very short Shower. 19 and 20, somewhat cloudy.

21, About seven *a. m.* a few Drops; after, clear and extream hot, but quickly cloudy again; at eleven *a. m.* a violent *Tornado*, with very strong Rain and Thunder for near an Hour; thence all the Time till Night, thick and misty; till two *p. m.* Rain. 22, Cloudy. 23, Clear and hot. 24, Somewhat cloudy; at seven *p. m.* a little Rain. 25, Cloudy; about eleven *a. m.* Expectation of a *Tornado*, with some Thunder, but it ended in a few Drops of Rain about one *p. m.* 26, About two *a. m.* a very violent *Tornado*; and after the Wind, Rain not very fierce, which lasted till eight *a. m.* the Day after cloudy. 27, About ten *p. m.* a violent Wind with Rain, but it lasted not long. 28, About three *a. m.* a strong Rain for near an Hour, the Day after extream hot. 29 and 30, Hot, yet with some Clouds. 30, Half an Hour after eleven *p. m.* began a very furious *Tornado*, the Wind was quickly over, but the Rain lasted with extream Violence about two Hours. 31, In the Morning very hot, about two *p. m.* a violent *Tornado*, with Rain and Thunder very near, it ceased

ceased sometimes, but beginning again, lasted till near four *p. m.* afterward cloudy.

Three Funerals, all upon the sixth Day; two of Fevers, the other I know not.

Nov. Clear and extream hot till the sixth. 6, About half an Hour past one in the Morning, a very violent Rain for more than an Hour.

Thence to 14, except that the eleventh at Night there were some few Drops, very hot.

14, Extream hot, about nine *p. m.* a little Shower; the same Night about one, a smart Rain for an Hour and half. 15, Hot, toward Night cloudy and foggy: Thence to 19 very hot. 19, Some Likelihood of a *Tornado*, but nothing followed.

20, About one *p. m.* a short Shower, about a Quarter past two another not much longer; till Night cloudy: Thence to 26, no Rain, but cloudy and somewhat cooler; yet some Days extream hot. 26, About ten *p. m.* a short Shower. 27, About two another, the rest clear. 30, About two *a. m.* fierce Rain for about half an Hour.

This last Year has been the wettest and most cloudy of any that can be here remembred; yet the Air has been clearer than it uses to be in *England* one Day with another. ib. p. 691.

A *Tornado* is a violent Storm of Wind, followed commonly by Rain, but not always; the Wind ceases not presently upon the Rain, but after, sometimes it does: In this Place it comes (as does an *Hermitan*) most frequently from the North, taking in the next Points, whether to the East or West, but chiefly the East, tho' I have seen both that and an *Hermitan* from other Points; so the Account is not without Exception. There are in it short uncertain Blasts from all Quarters, which I believe reach not many Yards, but the general Wind (for ought that I see) is not so unconstant; Vessels that go to Windward are helped by them, when they are not over-strong, for they are opposite to the *Sea-Breeze*, and they can steer by them a regular Course; which sure they could not do, if they were very irregular. They never fail to give Warning before-hand, tho' sometimes after that Warning they do not follow; there is a very black Cloud appears afar, in which if there be a kind of white Spot, the Wind will be most, if not the Rain; this the Saylor's say. Sometimes there is that Mark, sometimes not, tho' I doubt the Prediction from it is not very certain; as neither are any perhaps of that kind. ib. p. 692.

XXII.

The Rain at
Gresham
College,
1695 and
1696, n.
223. p. 357.

M.	D.	lb.	Oun.	gr.	M.	D.	lb.	Oun.	gr.	M.	D.	lb.	Oun.	gr.
Aug.	19	2	6	216	Jan.	6	4	10	105	May	4	4	10	45
	26	4	6	246		13	0	1	12		11	7	6	0
						20	1	10	450		18	5	2	105
Sept.	2	0	4	96		27	1	5	82		25	1	7	60
	9	3	10	397	Feb.	3	6	11	372	June	1	0	0	99
	16	0	1	204		10	4	9	242		8	6	6	150
	23	0	6	336		17	0	6	291		15	0	2	120
	30	4	1	444		24	0	2	180		22	7	5	285
Oct.	7	2	3	96							29	1	5	84
	14	0	2	60	March	2	0	9	12	July	6	0	1	120
	21	0	1	234		9	0	2	459		13	16	8	0
	28	0	0	458		16	0	0	396		20	1	7	240
Nov.	4	0	0	207		23	4	4	263		27	6	1	256
	11	1	11	65		30	1	5	285	Aug.	3	1	10	120
	18	1	1	309	April	6	2	4	375		10	1	11	90
	25	0	9	285		13	1	0	294		12	0	0	0
Dec.	2	0	8	126		20	2	2	000					
	9	3	7	324		27	0	7	390					
	16	1	3	435										
	23	0	1	60										
	30	5	8	93										

This Account of the Quantities of Rain fallen in one Year in *Gresham College, Lond.* per Month, begun *Aug.* 12, 1695, and the Rain was weigh'd every Monday Morning till *August* 12, 1696, by Pounds, Ounces and Grains, Troy Weight: The Diameter of the Vessel which receives the Rain being 11,4 Inches, whose Area is a little more than 102,1 Inches.

lb. Oun. gr.

The Sum amounted to 131 7 113, which is equal to 29,11 Inches in a Cylinder of the aforesaid Diameter, viz. 11,4 Inches.

Fig. 18.

ABCD is a Frame to support the Glasses. *E* is a large Bolt-head, with a Neck of twenty Inches long, and capable of holding above two Gallons. *F* is a Funnel, whose Diameter is eleven Inches and $\frac{4}{5}$ from *G* to *H*. *I, K*, are two Stays, or Pack-Threads which are strained by two Pins, *L, M*, to hold the Tunnel steady against the high Winds. *N*, the Pipe of the Tunnel, at *N* being no wider than $\frac{1}{2}$ of an Inch, through which the Evaporation can be but little.

JANUARY,

JANUARY, 1697.

D. h.	Weather.	Winds.	Barom.	Rain.	D. h.	Weather.	Winds.	Barom.	Rain.
8	Frost	W.S.W.	30 07		8	Frosty	N.	30 02	
1. 12			30 07		17. 12	Cloudy	N.N.W.	30 02	
9	Fair		30 04		9	Calm		30 04	
8			30 05		8	Frost	W.	30 09	
2. 12	Misling	S.	30 06		18. 12	Fair	S. W.	30 10	
9			30 05		9			30 10	
8	Fog	S. by W.	30 07		8				
3. 12	Cloudy	S.	30 11		19. 12				
9			30 15		9				
8			30 18	0 50	8	Fair			
4. 12	Misling	S.	30 18		20. 12	Frost			
9			30 18		9	Cloudy	S.w.b.w.	30 20	
8	Calm		30 22		8				
5. 12	and	W. by S.	30 23		21. 12				
9	Cloudy	S. W.	30 26		9				
8	Fog		30 22		8	Cloudy	W.	29 95	
6. 12	Warm	W.	30 00	0 30	22. 12	Thaw	W. by N.	29 90	0 08
9	Misling		30 14		9	Rain		29 95	
8		N. by W.	30 05		8	Frost	N. W.	29 90	
7. 12	Cloudy	N. W.	30 05		23. 12	Snow	N. W.	29 80	0 30
9					9	Fair	N.N.W.	29 68	
8		N. W.	29 94		8	Snow	N. W. by W.	29 64	
8. 12	Cloudy	N. W.	29 90		24. 12	Storm	N.	29 67	
9			29 82		9	Snow	N. E.	29 78	0 20
8							N. by E.	29 91	
8	Sunshine		29 51		8	Frost	E.	29 95	
9. 12	Rain	S.	29 38		25. 12	Fair	E. by N.	29 97	
9	Snow		29 10	1 20	9		N. E.	29 98	
8	Frost	S. W.	29 02		8	Sharp	N. E.	29 96	
10. 12	Thaw	S.	29 00		26. 12	Frost	N. by E.	29 96	
9	Rain	S. by E.	28 95	0 70	9		N. N. E.	29 86	
8	Cloudy		29 46		8			29 77	
11. 12	Fair	N.	29 00		27. 12	Frost	N. E.	29 77	
9			29 77		9			29 74	
8		N.	29 83		8	Cloudy	S.	29 65	
12. 12	Sleet				28. 12	Frost	N. E.	29 60	
9					9			29 60	
8					8	Snow	S.	29 47	
13. 12	Cloudy		29 91		19. 12	Thaw	S. W.	29 31	0 08
9					9			29 29	
8		N. E.	29 96		8	Frost	S. W.	29 41	
14. 12	Snow	N. E.	29 96	0 20	30. 12	Fair	W.	29 50	
9		E. N. E.	29 98		9		W. by S.	29 54	
8		E. N. E.	29 94		8	Frost	W.	29 77	0 05
15. 12	Cloudy	E.	29 92		31. 12	Fair	N.N.W.	29 86	
9			29 90		9		N. by W.	29 95	
8	Frost	E. N. E.	29 90					Total	3 61
16. 12	Cloudy	N.e.b.N.	29 91						
9			29 94						

XXIII.
The Weather
1697 at Up-
minster in
Essex; by
Mr. Will.
Detham, n.
237. P. 47.

F E B R U A R Y, 1697.

D.	h.	Weather.	Winds.	Barom.	Rain.	D.	h.	Weather.	Winds.	Barom.	Rain.
	7						7	Rain		29 50	
1.	12	Frost				17.	12	Fair	S.	29 52	0 20
	9			30 06			9	Rain		29 52	
	7	Cloudy		30 05			7	Cloudy	S. by E.	29 3	
2.	12		N. E.			18.	12	Blustering	S.	29 26	
	9	Frost		29 95			9	Fair		29 42	
	7	Cloudy	N.E.b.E.	29 75			7	Rain	E. by S.	29 30	
3.	12	Frost	E.	29 66		19.	12		S.	29 33	0 05
	9	Calm	S.	29 50			9	Fair		29 39	
	7	Cloudy		29 30			7		S. E.	29 40	
4.	12	Thaw	E. by S.	29 26	0 02	20.	12	Frost	E. by S.	29 46	
	9	Sleet		29 20			9		E.	29 40	
	7	Snow		29 20			7			29 36	
5.	12	Fair	E.	29 20	0 03	21.	12	Fair	E.	29 37	
	9	Frost		29 19			9			29 45	
	7	Frost	N. by E.	29 05			7	Rain		29 47	
6.	12	Cloudy		29 02	0 03	22.	12		E.	29 48	0 03
	9	Snow	N.	28 90			9	Fair		29 52	
	7	Snow	N.	28 86			7	Hoar-F.	E.	29 52	
7.	12	Cloudy	W. by S.	28 83	0 01	23.	12	Fair	S.	29 54	
	9		S. by W.	28 83			9	Rain	S.	29 60	
	7	Fairer		28 82			7			29 68	
8.	12	Sleet	S. W.	28 84	0 01	24.	12	Fair	S. by w.	29 75	0 04
	9			28 97			9	Rain		29 81	
	7	Thaw		29 10			7	Cloudy		29 84	
9.	12	Frost	S. W.	29 18		25.	12	Bluster	S.	29 85	
	9			29 25			9	Fair		29 88	
	7	Frost	S. W.	29 43			7	Fair	S.	29 88	
10.	12	Fair	S.w.b.w.	29 52		26.	12	Cloudy			0 10
	9			29 61			9	Rain	S. W.	29 92	
	7	Snow	S. by E.	29 65			7	Misting	S.	29 93	
11.	12	Rain	S. E.	29 76	0 27	27.	12	Fair	S. by W.	29 97	
	9	Fair	E.	29 94			9	Calm	S. S. W.	29 98	
	7	Cloudy	E. by S.	30 08			7	Cloudy		30 01	
	9	Frost		30 08		28.	12	Fair	S. W.	30 01	0 03
	7	Thaw		30 00			9	Cloudy		30 40	
13.	12	Warm	S.	30 00							
	9	Cloudy		29 95							
	7	Calm	S.	29 88							
14.	12	Rain	S. by W.	29 87	0 40						
	9		S.	29 80							
	7	Milt	N.	29 85							
15.	12	Warm	N. W.	29 86	0 30						
	9	Rain	E.	29 80							
	7	Cloudy	S. by E.	29 54						Total.	1 80
16.	12		W.S.W.	29 62	0 28						
	9	Fair		29 60							

MARCH, 1697.

D. h.	Weather.	Winds.	Barom.	Rain.	D. h.	Weather.	Winds.	Barom.	Rain.
7	Cloudy		30 12		7	Frost		29 16	
1. 12	Fair	S. W.	30 20		17. 12	Fair	N. W.	29 30	
9					9			29 32	
7	Cloudy	W.S.W.	30 18		7	Frost	S.	29 10	
2. 12	Warm	S. W.	30 19		18. 12	Snow	N. W.	29 10	
9	Spring		30 14		9		W.	29 16	
7	Fog	S.	30 02		7	Frost	W. by S.	29 27	
3. 12		W.	29 95		19. 12	Fair	N. W.	29 41	
9	Fair	W. by S.	29 88		9		S.W.b.S.	29 43	
7	Mist		29 75		7	Frost	S.	29 42	
4. 12	Rain	S. W.	29 69	0 13	20. 12	Snow	S. S. E.	29 37	0 52
9	Fair		29 65		9	Fair	S. E.	29 25	
7	Fair	S. W.	29 71		6	Blust.	E. by N.	29 07	
5. 12	Colder	S.	29 70		21. 12	Cloudy	E. by N.	29 10	
9			29 46		9	Hazy	N. N. E.	29 24	
7	Rain	S. W.	29 20		6				
6. 12	Bluster	W.	29 12	0 85	22. 12				
9	Fair		29 21		9				
7	Fair	W.	29 48		6				
7. 12	Colder	W. b. N.	29 57		23. 12				
9	Bluster	W.	29 60		9	Frost	N. E.	29 40	
7	Frost	N. W.	30 01		6	Frost	N.	29 46	
8. 12		N.	30 11		24. 12		N.N.W.	29 54	
9	Fair	N. by E.	30 15		9	Fair	N. by E.	29 70	
7	Frost	E.	30 15		6	Frost	N.b.E. r	29 78	
9. 12		W.	30 14		25. 12		S.	30 02	
9	Fair	S. W.	30 08		9	Fair	S.	30 11	
7	Mist	S. W.	29 95		6	The	E.	30 11	
10. 12		S.W.b.S.	29 90		26. 12	Same	Sie.b.e. r	30 10	
9	Fair	S. by W.	29 76		9			30 04	
7	Mist	S.	29 65		6			29 97	
11. 12	Frost	W. by S.	29 64		27. 12	Same	E.	29 98	
9	Cloudy		29 60		9			30 07	
7	Rain	N. W.	29 47		6	Same	E.	30 13	
12. 12	Fair	W.S.W.	29 35		28. 12	Hazy	E.	30 15	
9	Rain	W. by N.	29 21		9		E.	30 20	
7		N by W.	29 18		6	Cloudy	N.e.b.s.o	30 14	
13. 12	Rain	N.	29 25	0 32	29. 12	Cold	N.N.E. r	30 12	
9		N.	29 35		9			30 12	
7	Frost	N.	29 59		6	Cloudy	N. N. E.	30 12	
14. 12	Fair	W.	29 60	0 02	30. 12	warmer	N. N. E.	30 12	
9	Cloudy	W.	29 48		9			30 05	
7	Fair		29 40		6	Cloudy	N.	29 96	0 02
15. 12	Bluster	W.	29 48		31. 12				
9	Storms		29 28		9	Rain	N. by E.	29 88	
7	Fair		29 04					Total	20 68
16. 12	Hail	W.	29 04	0 82					
9	Snow.		28 93						

A P R I L, 1697.

D. h.	Weather.	Winds.	Barom.	Rain.	D. h.	Weather.	Winds.	Barom.	Rain.
6	Cloudy		29 83		6		N.b.w. 1	29 96	
1. 12	Warm	N. E. 0	29 83		17. 12	Fair	N. 1	29 96	
9	Fair		29 84		9			29 94	
6		N. 1	29 88		6	Fair	N. 0	29 91	
2. 12	Fair	N. E. 2	29 88		18. 12	Hot	E. N. E.	29 93	
9			29 87		9	Day		29 95	
6	Fair	N.e.b.e. 1	29 83		6			29 93	
3. 12	Want of	E. 1	29 82		19. 12	The	E. 1	29 80	
9	Rain		29 82		9	same			
6	Misting	N. 0	29 75		6	The	E. 0	29 69	
4. 12	Cloudy				20. 12	same	S. 1	29 60	
9	Fair		29 68		9		S. 0	29 52	
6	Cold		29 68		6	Cloudy	E by S. 0	29 35	
5. 12	Fair	N. by E.	29 68		21. 12	Fair	E. by S. 1	29 21	0 43
9	Misting		29 74		9	Rain	S. by F. 1	29 10	
6	Frost		29 73		6	Cloudy	E. 1	29 08	
6. 12	Fair	E.	29 71		22. 12	Rain	S. 1	29 05	0 30
9			29 68		9	Fair	S. E. 0	29 15	0 62
6	Frost		29 66		6	Fair	E. 0	29 20	
7. 12	Dry Sea-	E.	29 67		23. 12	Rain	S. by E. 1	29 22	0 06
9	son		29 70		9	Fair	S. E.	29 27	
6	Frost		29 71		6	Rain	S. E. 1	29 31	
8. 12	Warmer	E.	29 70		24. 12	Thunder	N. N. W.	29 32	1 24
9			29 71		9		E.	29 34	
6	Fog	W.	29 66		6	Showers	E. by N.	29 28	
9. 12	Fair	W.	29 64		25. 12		E. 0	29 27	0 75
9	Cloudy		29 64		9	Fair		29 18	
6	Warm	E. 0	29 61		6	Cloudy	S.	29 14	0 65
10. 12	and	E. by S. 1	29 61		26. 12				
9	Fair		29 60		9				
6	Fair	E. 0	29 60		6				
11. 12	Warm	E. 1	29 63		27. 12				
9	Cloudy	N.b.E. 2	29 64		9				
6	Fair	N. N. E. 2	29 65		6				
12. 12	Cloudy	N. by E.	29 67		28. 12				
9	Rain		29 70		9				
6	Cloudy		29 72		6				
13. 12	Rain	N. E.	29 78	2 38	29. 12				
9				0 30	9				
6		N.n.e. 0	29 75		6				
14. 12	Fair	E. by N. 0	29 76		30. 12				
9			29 76		9				
6	Fair		29 77						
15. 12	Warm	E. 1	29 77						0 80
9	Spr. Day		29 73						
6	Fair	E. 0	29 73						
16. 12			29 75						
9	Cloudy	N. 0	29 86					Total	7 53

(65)

M A Y, 1697.

					D. h.	Weather	Winds.	Barom.	Rain.
					6	Cloudy			
					17. 12	Mistling		29 65	3 0
					9	Blustering	S. W. 2	29 55	
					6	Rain	W. 2	29 57	
					18. 12	Fair	W.b.n. 1	29 65	0 19
					9			29 74	
					6		W b.S. 1	29 79	
					19. 12	Fair	E. 1	29 85	
					9			29 92	
					6	Fair	E.b.N. 0	29 99	
					20. 12		N. 2	30 02	
					9	Cool	N.b.E. 0	30 07	
					6	Cloudy	N. 0	30 08	
					21. 12	Cold	N.b.E. 1	30 08	
					9	Fair	N.b.E. 0	30 11	
					6	The	N.b.E. 0	30 07	
					22. 12	same	N.b.E. 0	30 07	
					9		E. 0	30 02	
					6	Cloudy	E. 0	29 98	
					23. 12	less cold	E.b.N. 0	29 93	
					9	Fair	E.b.N. 0	29 88	
					6	The	N.b.E. 0	29 85	
					24. 12	same			
					9		E. 0	29 88	
					6	Mist		29 88	
					25. 12	Hot and	E. 0		
					9	Dry		29 85	
					6	The	E. 0	29 83	
					26. 12	same	E. 1	29 80	
					9		E. 0	29 73	
					6	Fair	N. 0	29 65	
					27. 12	Little	N. 1	29 65	0 01
					9	Rain		29 75	
					6	Fair	N. 0	29 82	
					28. 12	Warm			
					9		S. 0	29 74	
					6	Fair	S. 0	29 79	
					29. 12	Hot	E. 0	29 75	
					9		E. 1	29 73	
					6	The	E. 0	29 73	
					30. 12	same		29 76	
					9		S. 0	29 80	
					6	The		29 80	
					31. 12	same	S. 0		
					9			29 75	
								Total	3 20

K

J U N E, 1697.

J U N E, 1897.											
D.	h	Weather.	Winds.	Barom.	Rain	D.	h	Weather.	Winds.	Barom.	Rain.
1.	6	Rain		29 60		17.	6	Cloudy	N.	29 90	
12	9	Hot	S. 0			17.	12	Fair	W. 1	29 92	
	9	Rain		29 56			9	Sultry	W. 0	29 94	
2.	6	Rain	S. 0	29 42			6	Very	W.b.S. 0	29 98	
12	9	Shine	S. 1	29 29	0 44	18.	12	drough-	W.b.S. 1	30 00	
	9	Rain	S. 1	29 10			9	ty	S.W. 0	30 00	
3.	6	Fair	S.b.W. 0	29 08	0 79		6	Hot	S.w.b.w. 2	29 93	
12	9	Showers	S. 1	29 04		19.	12	Rain	W.b.e. 1	29 91	0 22
	9		S.W. 2	29 18			9	Cloudy	N.E. 0	29 93	
4.	12	Cloudy	S. 1	29 38			6	Cloudy	N.b.E. 0	29 92	
	9			29 58		20.	12	Cooler	N. 1	29 92	
5.	6	Cloudy		29 72			9	Cloudy	N. 0	30 00	
12	9	Sultry	S.b.W. 1	29 83		21.	12	Much	N.E. 1	30 02	
	9	Hot		29 85			9	cooler	N. 0	30 01	
6.	6	Thund.	E. by S.	29 85			6	Fair	N. 0	30 01	
12	9	Rain	E. 0	29 82	1 13	22.	12	Fair	E. 1	29 90	
	9	Thund.		29 74			9		N.e.b.n. 0	29 90	
7.	6	Fog	S. by W.	29 70	0 02		6	Cloudy	N. 0	29 80	
12	9	Fair	S.W. 1	29 71		23.	12	Rain	E. 1	29 79	
	9	Hot	S.w.h.w.	20 72			9	Fair		29 79	
8.	6	Fair	S.w.b.w.	29 70			6	Great	N.e.b.e. 1	29 77	
12	9	Cloudy	S. 0	20 56		24.	12	Drought	E. 1	29 78	0 10
	9		S. by E. 0	29 50			9			29 78	
9.	12	Fair	S. 1	29 48			6	Cloudy	N.e.b.e. 0	29 74	
	9	Rain	S. 0	29 51		25.	12	Dry	N.E. 1	29 73	
10.	6	Fair	S. by E. 0	29 60			9		E. 1	29 71	
12	9	Fair	S.b.W. 1	29 68	0 01		6	Sultry	E. 0	29 71	0 05
	9		S. 0	29 75			9	Day		29 73	
11.	6	Fair	S. 0	29 75			6	Mitt	E. 0	29 74	
12	9	Fair	E. 0	29 65		27.	12	Rain	E. by S.	29 73	0 29
	9			29 60			9	Thunder	S. 0	29 74	
12.	6	Cloudy	N.W. 1	29 60			6	Mitt		29 81	
12	9	Fair	N.w.b.w	29 55		28.	12	Hot and	S. 1	29 83	
	9		N.W. 0	29 49			9	Dry		29 86	
13.	6	Fair	W. 0	29 40			6	Dry	E. 0	29 85	
12	9	Fair	S.W. 0	29 34		29.	12	Burning	E. 1	29 85	
	9		S.W. 0	29 28			9	Day	S. 0	29 87	
14.	6	Fair					6	Fair	S.W. 0	29 88	0 97
12	9	Rain	E. 0	29 38	0 02	30.	12	Rain	S. 1	29 88	0 31
15.	6	Mitty	E. 0	29 45							

(67)

J U L Y, 1697.

D.	h.	Weather.	Winds.	Barom.	Rain.	D.	h.	Weather.	Winds.	Barom.	Rain
	6	Rain	S. S. W.	29 75			6	Fair	W. b. n. o	29 91	
1.	12		S. W. 1	29 72		17.	12	and	N. o	29 93	
	9	Fair	S. W. o	29 70	o 24		9	Cool	N. N. w. o	29 93	
	6		S. W. o	29 67			6	Fair	N. W. 1	29 95	
2.	12	The same				18.	12	Cloudy			
	9		S. W. 1	29 59	o 22		9	Rain	N. 1	29 98	
	6		W. b. n. 1	29 64			6	Misting	N.	29 98	
3.	12	Fair		29 75		19.	12		W. N. w. 1	30 02	o 62
	9		W. o	29 84			9	Cloudy			
	6	Cloudy	S. o	29 85			6				
4.	12	Fair	S. W. 1	29 85		20.	12	Showry			
	9	Hot	S. W.	29 85			9		W. b. S. 1	29 88	
	6	Fair	W. o	29 87			6	Rain	W. S. w. 1	29 75	
5.	12	Cool				21.	12	Fair	W. b. n. 1	29 11	
	9	Breezes	W. 1	29 90			9	Misting	W. 1	29 60	
	6	Hot	W. o	29 95			6	Misty	S. w. b. w.	29 48	
6.	12	Dry	W. b. S. 1	29 94		22.	12	Rain			
	9	Day.		29 90			9	Fair	S. W. b. S.	29 50	o 43
	6	Fair	W. b. N. o	29 86			6	Fair	S. b. W. o	29 50	
7.	12	Hot				23.	12	Cool	S. 1	29 48	
	9	Rain	W. b. S. o	29 79	o 12		9	Day	S. o	29 48	
	6	Misting	S. W. 1	29 68			6	Fair Thun.	N. 1	29 50	
8.	12	Rain	S. W. 2	29 60		24.	12	great Sh.	W. & N.	29 56	
	9	Cloudy	S. S. W. 1	29 44	o 32		9	with Hail	& S.	29 60	1 02
	6	Rain	S. W. 1	29 42	o 75		6	Fair	W. o	29 65	
9.	12	Cool	S. W. 1	29 43		25.	12	Pleasant	N. W. 1	29 72	
	9	Fairer	W. N. W. o	29 47	o 77		9	Day	W. S. w. o	29 77	
	6	Fair	W. b. n. o	29 58			6	Fair		29 76	
10.	12	and	W. 1	29 71		26.	12	Cloudy	W. b. S. o	29 76	
	9	Cool	N. w. b. w	29 83			9	Misting		29 69	
	6	Rain		29 85			6	Cloudy	S. b. W. o	29 63	
11.	12	Warmer	S. W. 1	29 85		27.	12	and	S. s. S. b. w	29 60	
	9			29 93	o 50		9	Cool	E. b. N. 1	29 60	
	6		S. w. b. w.	30 00			6		N. N. e. 2	29 58	
12.	12					28.	12	The same	E. b. N. 2	29 62	
	9						9			29 69	
	6	Fair					6	Fair	N. 1	29 70	
13.	12	and				29.	12	Cool	N. 2	29 76	
	9	Hot	S. o	29 98			9	Day		29 90	
	6	Fair	S. o	29 90			6		N. b. W. o	29 77	
14.	12		S. b. W. 1	29 88		30.	12	The same	W. b. n. 1	30 00	
	9	Cloudy	S. W. 1	29 84			9			30 00	
	6	Rain	N. b. W. 1	29 84			6	Cloudy	S. b. E. 1	29 90	o 20
15.	12	Cloudy	W. 1	29 85	o 48	31.	12	Warmer	S. S. E. 1	29 86	
	9	Fair	N. W. o	29 90			9	Rain	S. 1	29 79	
	6	Cooler	W. 1	29 95						Total	6 09
16.	12	Rain	N. w. b. w	29 94							
	9	Thunder		29 92	o 42						

AUGUST, 1697.

D	h.	Weather.	Winds.	Barom.	Rain.	D	h.	Weather.	Winds.	Barom.	Rain.
	6	Cloudy	S.by E. 1	29 73			6		S. 0	29 48	
1.	12	Cloudy	S.by E. 2	29 72		17.	12				
	9	Rain	S.b. E. 2	29 65			9				
	6	Fair	S.b. E. 0	29 63	0 51		6				
2.	12	Showers	W.b.S. 1	92 65		18.	12				
	9	Fair		29 68	0 40		9				
	6	Rain	S.by E. 2	29 69			6				
3.	12	Cloudy	W. 3	29 71		19.	12				
	9	Fair		29 78	0 05		9				
	6	Rain	S.w.b. 1.1	29 67			6	Fair	S.b.W. 2		
4.	12		S.b.W. 2	29 65		20.	12	Great Storm Thunder			
	9	Fairer	W. 1	29 70	1 00		9	Rain		29 60	1 88
	6	Rain					6	Cloudy		29 60	
5.	12		S. W. 2	29 50		21.	12	Rain	S. 1	29 60	
	9	Fairer	S. W. 1	29 49	0 79		9	Cloudy		29 61	0 13
	6	The	S.b.W. 0	29 47			6	Cloudy	W.b.S. 0	29 74	
6.	12	fame	S. 1	29 48		22.	12	Mifling	W. 1	29 84	
	9			29 49	0 22		9	Fair	W. 1	29 90	
	6	Cloudy	S.by E. 0	29 51			6	Fair	W.b.S. 0	29 92	
7.	12	Rain	E.b.N. 1	29 55		23.	12		W.b.S. 2	29 88	
	9	Fairer	E.N.E. 1	29 58	0 07		9	Cloudy	S. W. 2	29 84	
	6		N. 2	29 50			6	Fair		29 82	
8.	12	Rain	N. 1	29 48	4 00	24.	12		S. W. 1		
	9	both	N. 2	29 35	0 91		9	Sultry		29 78	
	6		W. 2	29 37			6	Cloudy	S.w.b.f. 1	29 70	
9.	12	Days	W.b.S. 1	29 42	0 50	25.	12		S.w.b.f. 2	29 67	
	9			29 48	2 20		9	Fair	S.b.W. 2	29 54	
	6	Cloudy	W. 1	29 66	0 39		6	Rain	S. 3	29 29	
10.	12	Rain	N. W. 2	29 66		26.	12		W.b.S. 3	29 31	
	9	Fairer	W. 1	29 75	0 07		9	Fair		29 54	0 53
	6	Fair	W. 0	29 77			6		S. W. 1	29 81	
11.	12	Pleasant	W. 1	29 80		27.	12	Fair	W.b.S. 2	29 93	
	9	Day	W.n.w. 1	29 82			9			29 98	
	6	Cloudy	W.b.n. 0	29 82			6		S.S.W. 0	29 94	
12.	12		W.b.n. 0	29 82		28.	12	Fair	S.S.W. 2	29 94	
	9	Fair	N. 6	29 85			9			29 90	
	6	Mit	N. 0	29 88			6	Cloudy	S. W. 0	29 95	
13.	12	Cloudy	W.b.S. 1	29 89		29.	12	Sultry	E. 0	29 99	
	9	Rain	S.b.W. 1	29 83	0 33		9	Very l.		30 03	
	6	Cloudy	S. W. 2	29 73			6		N. E. 0	30 03	
14.	12		W. 2	29 83		30.	12	Fair			
	9	Fair	W. 2	29 88			9				
	6	Cloudy	S. W. 1	29 84			6	Fair			
15.	12	Little	W.b.S. 2	29 81		31.	12	and			
	9	Rain	S.w.b.w. 1	29 75			9	Shar. Air		30 01	
	6	Cloudy		29 70						Total	13 98
16.	12	Fair	S. 1	29 62							
	9	Cloudy		29 53							

SEPTEMBER, 1697.

D.	h.	Weather.	Winds.	Barom.	Rain.
	6	Fair	E.b.N. 1	29 98	
1.	12		N. E. 2	30 00	
	9	Cool		30 98	
	6		N.e.N. 3	29 93	
2.	12	The	N. E. 2	29 92	
	9	fame		29 90	
	6	Hot Sun	E.by N. 0	29 88	
3.	12	but	E. 1	29 89	
	9	Cool Air	E.	29 89	
	6	Fair	E. 0	29 84	
4.	12	Warmer	E. 2	29 84	
	9	Air		29 80	
	6	Fair	E. 1	29 78	
5.	12		E. 0	29 80	
	9	Hot		29 83	
	6	Mitt	E. 0	29 83	
6.	12	Fair	S. b. E. 0	29 86	
	9	Hot		29 87	
	6		S. 0	29 85	
7.	12	The	E. 2	29 83	
	9	fame	E. 0	29 80	
	6		E. 0	29 73	
8.	12	The			
	9	fame		29 70	
	6	Fair	E.b.N. 1	29 68	
9.	12		E.b.N. 2	29 66	
	9	Cooler		29 56	
	6	Cloudy	E. 1	29 43	
10.	12		S. 2	29 39	
	9	Rain		29 40	0 10
	6		S. b. E. 0	29 38	
11.	12	Showers	W.S.w. 1	29 40	
	9			29 60	1 59
	6	Fair	S. 0	29 76	0 07
12.	12		S. b. w. 2	29 77	
	9	Cloudy		29 70	
	6	Rain	S. 2	29 49	
13.	12		S. 3	29 38	
	9	Fair		29 63	1 54
	6		S. 0	29 67	
14.	12	Rain	S. 2	29 50	
	9		S. 4	29 32	3
	6	Fair	S. W. 1	29 46	
15.	12			29 30	
	9	Rain	3	29 30	
	6	Fair	S. W. 4	29 28	
16.	12	Cool	W.b.S. 6	29 32	
	9	Cloudy	2	29 34	

D.	h.	Weather.	Winds.	Barom.	Rain.
	6	Fair	W. 1	29 45	
17.	12	Cool			
	9		0	29 75	
	6		E. by S. 0	29 55	
18.	12	Rain	S. S.W. 2	29 34	3 10
	9		S. W. 2	29 10	1 60
	6	Fair	W.b.n. 0	29 38	
19.	12	Cloudy	S. W. 1	29 50	
	9	Rain	S. 1	29 32	0 56
	6	Rain	S. W. 3	29 05	
20.	12		W.S.w. 3	29 02	
	9	Fair	3	29 21	0 14
	6	Cloudy	W.S.w. 3	29 35	
21.	12	Rain	S. 1	29 31	
	9	Cold	S. W. 1	28 98	
	6	Fair	S. W. 2	29 24	
22.	12	Shower			
	9			29 38	0 09
	6	Fair	S. W. 1	29 51	
23.	12				
	9	Rain	W.N.W	29 74	
	6		S. W. 0	29 87	
24.	12	Fair	N.		
	9	Rain		29 87	
	6		E. 0	29 66	0 08
25.	12	Cloudy	S. E. 2		
	9	Mifling		29 38	0 30
	6	Fair	N. E. 0	29 38	
26.	12	Rain	E. 1	29 40	
	9	Cold		29 30	0 24
	6	Fair	E. 0	29 27	
27.	12	Cloudy	E.by N. 1	29 25	
	9	Rain		29 30	0 84
	6	Fair	N. E. 1	29 38	
28.	12	Cold	N.b.E. 3		
	9	Day		29 56	
	6	Hoar-F.	N.b.W. 1	29 65	
29.	12		N.b.W. 1	29 70	
	9	Fair		29 78	
	6	Ice	N.b.W. 0	29 80	
30.	12	Fair		29 82	
	9	Cloudy		29 83	0 22
			Total		10 47

OCTOBER, 1897.

D.	h.	Weather.	Winds.	Barom.	Rain.	D.	h.	Weather.	Winds.	Barom.	Rain.
1.	7	Cloudy	N.W. 0	29 79	0	17.	7	Same	N.b.w. 0	30 27	
	12	Misty	S. 1	29 79			12	Same	N.b.E. 1	30 30	
	9	Warm	S. 0	29 78			9			30 34	
2.	7	Rain	S. 0	29 77	0 10	18.	7	Cloudy	N.byE. 0	30 32	
	12	Cloudy	S.b.E. 0	29 75			12	Fair		30 33	
	9	Warm		29 70			9	Colder	E.byS. 0	30 27	
3.	7	Cloudy	S.b.E. 0	29 51		19.	7	Hoar-f.	S.W. 0	30 22	
	12		S. 1	29 40			12	Mist	N.byE. 0	30 28	
	9	Rain		29 31	0 72		9	Fair		30 30	
4.	7	Fair	S.w.b.w. 1	29 50		20.	7	Fog-r.r.	N.W. 0	30 28	
	12	Cold	S.W. 2	29 52			12	Cool	S.W. 0	30 26	
	9	Rain		29 28			9			30 23	
5.	7		S. 4	29 00	1 12	21.	7	Cloudy	W.s.w. 1	30 15	
	12	Rain	S.b.w. 2	28 98			12	Fair	W.b.S. 1	30 16	
	9			29 13	0 57		9			30 20	
6.	7	Rain	S. 1	29 16		22.	7	Fog	W.D.S. 0	30 25	
	12	Stormy	E. & W. 1	29 97			12		S.W. 0	30 25	
	9	Fairer	S. & 6	29 28	1 36		9			30 25	
7.	7	Rain	S.b.E. 1	29 08		23.	7	Cloudy	S.S.W. 0	30 22	
	12		N. 1	29 13			12	Fair		30 15	
	9	Fair	W. 1	29 58	2 52		9	Cloudy		30 15	
8.	7	Rain	S. 2	29 66		24.	7	Cloudy	S.W. 0	30 06	
	12	Cloudy	S.W. 4	29 64	0 10		12	and			
	9	Stormy	5	29 44			9	Warm		29 94	
9.	7	Stormy	S.W. 8	29 39		25.	7	Same	S.W. 2	29 80	
	12	Cloudy	W.S.w. 4	29 51			12		W.S.w. 2	29 78	
	9	Fairer	2	29 66			9			29 74	
10.	7	Fair	S.w.b.w. 0	29 88		26.	7	Cloudy	S.W. 2	29 60	
	12	and	W.b.S. 0	30 00			12	Warm	S.W. 6	29 52	
	9	Pleasant		30 15			9	Rain		29 27	
11.	7	Frost	W.b.S. 0	30 20		27.	7	Fair	S.W. 2	29 37	1 52
	12	and		30 21			12	Rain	S.w.b.w. 5	29 34	
	9	Misty	S.W. 0	30 18			9	Stormy		29 88	0 21
12.	7	Frost	S.w.b.w. 0	30 17		28.	7	Frost	S.W. 0	30 08	
	12						12	Fair			
	9	Fair					9	Rain		29 89	
13.	7	Fair				29.	7	Warm	S.W. 4	29 78	
	12		W. 1	30 20			12	Small			0 02
	9						9	Showers	3	29 74	
14.	7	Fair	W.b.S. 0	30 18		30.	7	Cloudy	W.byS. 5	29 48	
	12	and	W.n.w. 0	30 18			12		W. 6	29 54	
	9	Warm		30 16			9	Fair		29 75	
15.	7	Cloudy	W.b.S. 0	30 12		31.	7	Fair	N. 0	30 04	0 01
	12	Warm	N.W. 0	30 12			12	and	N.E. 2	30 17	
	9	Misting		30 10			9	Cool		30 26	
16.	7	Cloudy	W. 0	30 06						Total	8 39
	12	Fair	N.n.w. 2	30 08	0 14						
	9	Cold	N.byW. 1	30 20							

DECEMBER, 1897.

D. h.	Weather.	Winds.	Barom.	Rain.	D. h.	Weather.	Winds.	Barom.	Rain.
8	Hard	W.b.N.0	29 86		8	Frost		29 57	
1. 12	Frost &	W.b.N.2	29 87		17. 12	Cloudy	E. 0	29 56	
9	Fair		29 89		9	Fairer		29 62	
8		N. 1	29 90		8			29 64	
2. 12	Same	N. 0	29 94		18. 12	Mist	E. 0		
9			29 99		9			29 72	
8		N. 0	30 05		8	Cloudy		29 70	
3. 12	Same	N.N.E.0	30 08		19. 12	Warm	E. 1	29 68	
9			30 06		9	Day		29 63	
8	Cloudy	N. W. 1	29 98		8	Fog	E. 2	29 50	
4. 12	Snow	W.n.w.1	29 89		20. 12	Cloudy			
9	half inch		29 96		9	Colder		29 44	
8	Cloudy	N.b.E. 2	30 00		8	Rain		29 45	0 23
5. 12	Fair	N. N.e.1	30 06		21. 12	Cloudy	E. 1	29 51	
9			30 09		9	Cold		29 62	0 17
8	Snow	N.w.b.n.3	29 98		8	Rain		29 75	0 02
6. 12	Fair	N.w.b.n.1	29 99		22. 12	Cloudy	E. 1		
9	Sn. 1 inch		29 00		9	Fair		29 90	
8	Snow 6	N. W. 0	29 93		8		S.b.E. 1	29 83	
7. 12	Snow 8	S. 0	29 71		23. 12	Cloudy	S. 1	29 76	
9	Inches		29 68		9			29 64	
8			29 84		8		S.b.W. 2	29 52	0 46
8. 12	Fair	E. 0	29 87		24. 12	Rain	S. 2	29 46	
9			29 85		9	Stormy		29 34	0 56
8	Snow		29 64		8	Fair	W. 3	29 25	
9. 12	Sleet	S. by E. 1	29 55		25. 12	and	S. W. 2	29 40	
9	Thaw		29 42		9	Warm		29 61	0 03
8	Frost	E.N.E.0	29 55		8	Cloudy	W.S.w.2	29 62	
10. 12	Thaw	E. 0	29 57	3 62	26. 12	Fair	W.b.S. 2	29 70	
9	Snow	2	29 46		9	Warm	3	29 87	
8	Rain	E.S.E. 2	29 09	2 76	8	Cloudy	W.S.w.2	29 90	
11. 12	Warm	S.b.W. 1	29 10		27. 12				
9	Thaw		29 24	0 90	9	Misting		29 82	
8	Thaw	S. by E. 2	29 14		8	Cloudy	S. by W. 0	29 66	
12. 12		S. 2	29 04		28. 12	Rain	W.b.S. 3	29 56	
9	Rain		29 11	0 42	9	Fair		29 75	0 08
8	Fair	S. W. 3	29 33		8	Fair	W. 2	29 90	
13. 12	Warm	W.S.w.3	29 50		29. 12	Cloudy	W.b.n. 2	29 97	
9	Pleasant	S. W. 1	29 61		9	Rain	0	29 97	
8	Cloudy	S. W. 1	29 68		8	Fair	N.E. 1	30 10	0 05
14. 12	Warm	W.S.w.1	29 57		30. 12	Cloudy	N. E. 1	30 15	
9	Day	W.S.w.0	29 65		9	Fair		30 20	
8	Misty	E. 1	29 64		8	Frost	E. 0	30 18	0 01
15. 12	Warm	N.b.E. 0	29 64		31. 12	Cloudy	E. b. S. 0	30 15	
9	Day		29 65		9	Fair		30 08	
8	Frost							Total	9 31
16. 12		E. b. N. 1	29 58						
9	Fair		29 59						

Where only one sort of Weather is noted upon one Day, that was the Weather of all the Day; especially if the Barometer be noted three times. The same observe also in the Column of Winds.

I have noted in the Column of Weather, the Depth of the Snow upon the Ground.

The whole Quantity of Rain that fell through my Tunnel last Year, was 77,60 l. which is less than fell from the Beginning of *March* (at which time I began my Rain Observations) till the End of *December* 1696. In which ten Months there fell here, at *Upminster*, almost 115 l. and at *Townley* in *Lancashire* (according to Mr. *Townley's* Observations) above 172 l. and in the whole Year at *Townley* 203,76 l.

The Weather
1698 at Up-
minster; by
Mr. Will.
Derham, n.
249. p. 45.

The greatest Range I have ever observed the Mercury to have, is no more than 2,12 Inches; it being here never higher than 30,40 nor lower than 28,28 Inches. The lowest it ever was, within my Observations, was Jan. 24, about two of the Clock in the Afternoon; about which Hour Mr. Townley observed his Barometer to fall to 27,80 Inches, which, he says, was remarkably low.

10.11	Same	N	0.10	74
8	Same	N	0.10	71
0	Same	N	0.10	70
12.11	For	N	1.00	68
3	Same	N	0.10	67
0	Same	N	0.10	66
14.11	Cloudy	N	1.00	65
8	Same	N	0.10	64
0	Same	N	0.10	63
10.11	Same	N	0.10	62
0	Same	N	0.10	61
0	Same	N	0.10	60
0	Same	N	0.10	59
0	Same	N	0.10	58
0	Same	N	0.10	57
0	Same	N	0.10	56
0	Same	N	0.10	55
0	Same	N	0.10	54
0	Same	N	0.10	53
0	Same	N	0.10	52
0	Same	N	0.10	51
0	Same	N	0.10	50
0	Same	N	0.10	49
0	Same	N	0.10	48
0	Same	N	0.10	47
0	Same	N	0.10	46
0	Same	N	0.10	45
0	Same	N	0.10	44
0	Same	N	0.10	43
0	Same	N	0.10	42
0	Same	N	0.10	41
0	Same	N	0.10	40
0	Same	N	0.10	39
0	Same	N	0.10	38
0	Same	N	0.10	37
0	Same	N	0.10	36
0	Same	N	0.10	35
0	Same	N	0.10	34
0	Same	N	0.10	33
0	Same	N	0.10	32
0	Same	N	0.10	31
0	Same	N	0.10	30
0	Same	N	0.10	29
0	Same	N	0.10	28
0	Same	N	0.10	27
0	Same	N	0.10	26
0	Same	N	0.10	25
0	Same	N	0.10	24
0	Same	N	0.10	23
0	Same	N	0.10	22
0	Same	N	0.10	21
0	Same	N	0.10	20
0	Same	N	0.10	19
0	Same	N	0.10	18
0	Same	N	0.10	17
0	Same	N	0.10	16
0	Same	N	0.10	15
0	Same	N	0.10	14
0	Same	N	0.10	13
0	Same	N	0.10	12
0	Same	N	0.10	11
0	Same	N	0.10	10
0	Same	N	0.10	9
0	Same	N	0.10	8
0	Same	N	0.10	7
0	Same	N	0.10	6
0	Same	N	0.10	5
0	Same	N	0.10	4
0	Same	N	0.10	3
0	Same	N	0.10	2
0	Same	N	0.10	1
0	Same	N	0.10	0

JANUARY, 1698.

D. h.	Weather.	Winds.	Barom.	Rain.	D. h.	Weather	Winds.	Barom.	Rain.
8	Frost	S. E. 0	29 95		8	Snow	N. W. 0	29 57	
1. 12	Fair	S. by E. 1	29 90		17. 12	Snow with the former, 5 inches.	E. 1. N. E. 2	29 60	
9	Hard Fr.	0	29 82		9		N. b. E. 1	29 65	
8	Cloudy	S. b. E. 1	29 63		8	Little	N. 1	29 68	
2. 12	Frost	S. b. E. 2	29 48		18. 12	Snow, very Cold.	N. 2	29 69	
9	Snow	0	29 26		9		N. b. E. 2	29 71	
8	Snow	W. b. S. 0	29 15		8	Snow 3 inches more.	E. 0	29 62	
3. 12	1 Inch. Rain		28 94	0 55	19. 12	Cloudy all Day.	E. by S. 2	29 59	
8	Rain Sleet	E. 0	28 80	0 99	9		2	29 59	
4. 12	Snow & Cloudy	E. 0	28 88		8	Cloudy	E. b. N. 3	29 65	
9			29 18	2 98	20. 12	Very cold Day	E. b. N. 3	29 70	
8	Frost	W. 0	29 44	0 20	9		2	29 84	
5. 12	Fair	W. S. w. 1	29 53		8	Hard Fr	E. b. N. 2	29 92	
9	Cloudy		29 64	0 33	21. 12	and Cloudy as before	E. b. N. 2	29 95	
8	Rain	E. 1	29 49	0 20	9		1	29 95	
6. 12	Fair	E. b. N. 1	29 50		8	Fairer	E. b. S. 0	29 82	
9	Cloudy		29 78	0 23	22. 12	Very Cold.	E. 1	29 68	
8	Frost	N. b. W. 1	29 98		9		E. 3	29 30	
7. 12	Fair	N. 1	30 04		8	Snow 5 inches, Cloudy, Snowy Day.	E. b. N. 0	29 00	
9	Snow re.		30 14		23. 12		N. E. 1	29 00	
8	Frost	N. b. E. 1	30 18		9			29 07	
8. 12	Showers of Snow	N. N. E. 2	30 18		8	Snow 3 inches, Sleet	E. b. S. 1	28 73	
9			30 16		24. 12	Thaw	S. E. 2	28 38	2 07
8	Cloudy	N. E. 2	30 07		9		S. W. 1	28 31	
9. 12	Cold Day	N. E. b. a. 2	30 04		8	Thaw	S. 2	28 38	0 30
9			30 00		25. 12	Showers of Rain.	S. 1	28 40	0 32
8	Frost	N. E. 1	29 90		9			28 56	0 32
10. 12	Cloudy Day		29 89		8	Rain	S. 0	28 72	0 28
9					26. 12	Thaw with Showers		28 94	0 06
8	Same but less	N. E. 0	29 79		9				
11. 12	Cold		29 73		8	Fairer	S. b. W. 0	29 03	0 08
9			29 61		27. 12	Rain	S. b. E. 1	29 00	
8	Cloudy	N. E. 0	29 61		9			28 88	0 30
12. 12	Fairer	S. o. W. 1	29 53		8	Frost & Fair	W. b. S. 0	28 98	0 14
9	Fair		29 36		28. 12	Rain	S. S. w. 1	28 88	
8	Frost	S. 0	29 21		9		S. e. b. f. 1	28 68	0 28
13. 12	Fair	W. 0	29 18		8	Same with Bluffing.	S. W. 2	28 90	
9	Snow		29 16		29. 12	Snow	S. S. E. 4	28 67	
8	Snow 3	N. N. w. 1	29 23		9		4	28 53	0 76
14. 12	Cloudy	N. N. w. 1	29 29		8	Frost	W. b. S. 1	28 92	0 48
9	Fair	N. 1	29 40		30. 12	Fair, pleasant Day.	W. 2	29 06	
8	Hard	N. b. w. 1	29 52		9			29 51	
15. 12	Frost	N. 1	29 65		8	Fair	N. W. 0	29 70	0 30
9	Fair	N. 0	29 79		31. 12	Wet Afternoon.	S. W. 1	29 71	
8		N. by w. 0	29 77		9			29 58	
16. 12	Same	N. 0	29 74					Total	10 94

(75)

FEBRUARY, 1698.

D. b.	Weather.	Winds.	Barom.	Rain.	D. b.	Weather.	Winds.	Barom.	Rain.
7	Misting	S. W. 2	29 48		7	Cloudy	E.b.N. 2	29 42	
1. 12					17. 12	Sleet, less	E.b.N. 1	29 38	
9	Warm				9	Cold.		29 43	
7	Fair				7	Fairer	E. 0	29 46	0 14
2. 12					18. 12	Cloudy	E.b.N. 1	29 50	0 14
9	Misting	4	29 11		9	Thaw		29 52	0 16
7	Fair	W.b.S. 3	28 97	0 34	9	Rain			
3. 12	Cloudy	W.S.w. 4	29 06		7	Cloudy	E. 2	29 51	0 15
9	Fair	1	29 26		19. 12	Rain	E.b.N. 2	29 55	0 15
7	Frost	S. W. 0	29 36		9	Cloudy		29 68	0 28
4. 12	Fair and	W. 1	29 42		7	Fairer	E.b.N. 2	29 68	
9	Pleasant		29 63		10. 12	Colder	E.b.N. 3	29 71	
7		N. 1	29 86		9	Freezing		29 75	
5. 12	The same	N. E. 1	30 06		7	Frost	E.b.N. 1	29 81	
9					21. 12	Fair and	E.b.N. 2	29 84	
7	Frost	E.b.N. 1	30 08		9	Pleasant	0	29 84	
6. 12	and	E. 1	30 08		7	Same	N. E. 0	29 85	
9	Cloudy				22. 12		E.b.N. 1	29 88	
7	Frost	E.b.N. 0	30 01		9			29 90	
7. 12	Fair and	W. 1	30 01		7	Frost &	E.b.N. 0	29 94	
9	Warm	0	29 96		23. 12	Fair	E. 1	29 97	
7	Frost	E by N. 0	29 88		9	Cl. warm		30 00	
8. 12	Fair	E. 0	29 89		7	Cloudy	E. 0	29 96	
9	Cooler		29 89		24. 12	Fr. Cold	E. 1	29 97	
7		E.b.N. 0	29 83		9	Fair		29 97	
9. 12	Same	E.N.E. 1	29 84		7	Mist Fr.	E.b.N. 0	29 95	
9		0	29 91		25. 12	Fair and	E. 0	29 95	
7	Cloudy	N. E. 1	29 99		9	Warmer		29 93	
10. 12	Cold	N. E. 2	30 02		7	Frost	E. 0	29 88	
9	Fair		30 07		26. 12		E. 1	29 88	
7	Frost	N. E. 1	30 08		9	Cloudy		29 88	
11. 12	and	E.b.N. 2	30 08		7	Frost and	E. 0	29 79	
9	Fair	N. E. 1	30 11		27. 12	Fair	E. 1	29 78	
7	Fair Cl.	E.N.E. 1	29 90		9	Warmer	S. W.	29 70	
12. 12	with	N. E. 2	29 87		7	Cloudy			
9	Frost	2	29 85		28. 12	Rain	S.w.b.l. 1	29 60	0 24
7	Frost Cl.	E.N.E. 3	29 84		9	Fair and			
13. 12	and very	N. E. 4	29 86			Thaw			
9	Cold	N. E. 3	29 94					Total	3 31
7		N.b.W. 0	29 83						
14. 12	Snow	N.w.b.n. 2	29 86						
9		4	29 86						
7	Snow	N. E. 3	29 86						
15. 12	half inch	N.e.b.n. 4	29 81						
9	Very cold	2	29 72						
7	Sa. 1 Inch	N.e.b.e. 3	29 63						
16. 12	Very	E.N.E. 3	29 56						
9	Cold		29 53						

((76))

MARCH, 1698.

D. h.	Weather.	Winds.	Barom.	Rain.	D. h.	Weather.	Winds.	Barom.	Rain.
6	Fair				6	Same	S. 1	29 80	
1. 12	warm &				17. 12	Same	S. W. 2	29 68	
9	Pleasant		29 60		9	Rain	S.b.W. 3	29 43	
6	Fair	S. S. E. 0	29 39		6	Fairer	W.b.S. 4	29 24	0 23
2. 12	Warm	S. b. w. 1	29 38		18. 12	Hail and	W.b.S. 7	29 36	
9	Rain	N. w b w. 1	29 60	0 32	9	Cooler	1	29 50	0 09
6		N. W. 1	29 74		6	Hoar Fr.	S. W. 0	29 60	
3. 12	Cloudy	N. 2	30 00		19. 12	Fair	W. 2	29 74	
9			30 00		9	Rain	0	29 78	
6	Cloudy	N. 1	30 05		6	Cloudy	W.s.b.W. 2	29 76	0 01
4. 12	Colder	N.b.E. 2	30 10		20. 12		S. W. 3	29 78	
9	Day		30 19		9	Warmer		29 78	
6	Cloudy	N. E. 1	30 10		6		S.S.W. 2	29 68	
5. 12	Cold	E.b.N. 2	30 10		21. 12	Same	S. W. 3	29 58	
9	Winds		30 05		9				
6	Frost	N. E. 0	29 92		6	Cloudy	S.S.W. 1	29 59	
6. 12		N. E. 1	29 90		22. 12		W. 1	29 73	
9	Fair		29 83		9	Fair	N. W. 0	29 98	
6	Frost	N. E. 2	29 72		6	Frost	N.b.W. 0	30 11	
7. 12	Cloudy	N.e.b.e. 3	29 74		23. 12	Fair and	S. 1	30 14	
9	Cold		29 74		9	Pleasant	S. W. 0	30 14	
6	Frost	N. E. 0	29 70		6		S.by E. 0	30 09	
8. 12	Cloudy	N.e.b.e. 1	29 71		24. 12	Same	E.b.S. 1	30 08	
9	Warmer		29 80		9			30 00	
6	Fo and Fair	S.e.b.e. 0	29 81		6	Frost	E.b.N. 0	29 90	
9. 12	and Sharp	S. 1	29 76		25. 12	Fair	E. 1	29 88	
9	Rain		29 68		9	Rain		29 83	
6	Cloudy	S. 0	29 51	1 49	6	Fair very	E. 0	29 77	0 38
10. 12	Showers	W. 2	29 54		26. 12	Warm	E. b. S. 1	29 77	
9	Fair		29 71	0 10	9	Lightning		29 71	
6	Showers	S. 1	29 63		6	Milly	S. W. 0	29 73	
11. 12		S.S.W. 2	29 42		27. 12	Fair	S. 1	29 75	
9	Fairer	S. W. 2	29 61	0 70	9	Cloudy		29 66	
6	Rain	S.S.W. 3	29 42	0 20	6	Rain	S. 2	29 42	0 28
12. 12	Warm	S. W. 5	29 35		28. 12	Cloudy	S.b.W. 4	29 34	
9	Showers	S. W. 3	29 39	0 98	9	Cooler		29 46	0 05
6		S.W.b.W. 2	29 63		6	Fair	W.S.w. 1	29 63	
13. 12	Fair	S.W.b.w. 2	29 60		29. 12		W.b.S. 2	29 70	
9		W.S.w. 2	29 78		9	Showers		29 79	0 06
6	Warm	S.w.b.w. 2	29 74		6	Hoar	S. 0	29 70	
14. 12	Cloudy	S.w.b.w. 4	29 74		30. 12	Frost	S. W. 3	29 59	
9	Day		29 84		9	Rain		29 46	0 34
6		S. W. 2	29 87		6	Rain	E.by N. 0	29 36	2 52
15. 12	Same	S. W. 3	29 80		31. 12	Rain	N. 2	29 49	1 52
9		W.b.S. 2	29 95		9	Fairer		29 72	9 33
6		W.S.w. 2	30 02						
16. 12	Same		30 03					Total	9 33

(77)

A P R I L, 1698.

D. h.	Weather.	Winds.	Barom.	Rain	D. h.	Weather.	Winds.	Barom.	Rain.
6		S by E. 0	29 68		0	Fair	N.b.w. 2	29 87	
1. 12	Rain	S.S.W. 1	29 48		17. 12	and	N. 2	29 88	
9			29 26	1 47	9	Cold	N.b.E. 1	29 92	
6	Cloudy	W.S.w. 2	29 27	0 11	6		N.b.w. 1	29 90	
2. 12		W.n.w. 3	29 40		18. 12				
9	Fair		29 57		9				
6	Hoar Fr.	S. W. 0	29 62		6	Cloudy			
3. 12	Fair	W. 1	29 71		19. 12	Warm	N. 1	29 88	
9	Rain		29 83	0 26	9	Rain		29 90	
6		E.b.N. 0	29 90	0 03	6	Cloudy	W. 1	29 80	0 44
4. 12	Fair	N. E. 1	29 95		20. 12	Rain	W.S.w.	29 68	
9			30 00		9			29 42	
6		N.N.E. 1	29 97		6	Fair and	W. 2	29 28	0 37
5. 12	Same				21. 12	Cold	W.b.n. 2	29 30	
9					9	Cloudy		29 26	
6	Cloudy		29 88		6	Rain	N. 3	29 34	0 19
7. 12	Fair	N.N.e. 0	29 94		22. 12	Snow	N.N.w. 3	29 43	
9	Cloudy	E. 2	29 91		9	Fair		29 44	0 03
6			29 79		6	Ice, very	E.S.E. 1	29 32	
8. 12	Showers	S.b.W. 2	29 65		23. 12	Cold.	S. E. 2	29 29	
9		N.W. 2	29 71		9	Rain		29 28	0 48
6			29 83	0 22	6	Misting	E.b.S. 0	29 31	
9					24. 12	Warmer	E. 1	29 46	
6	Hoar Fr.	S. W. 0	29 83		9	Fair		29 68	
9. 12	Cloudy	S. W. 2	29 82		6	Showers	S. W. 1	29 70	
9	Fair	S. 0	29 82		25. 12		W. 2		
6		S.b.W. 2	29 75		9	Fair		29 83	0 42
10. 12	Cloudy	S.S.w. 2	29 67		6	Fair	W. 2	29 83	
9			29 64		26. 12	Hail	W. 3	29 80	
6	Fair	S. W. 1	29 66		9	Showers		29 63	
11. 12	with				6	Snow	W.b.S. 2	29 56	0 89
9	Showers	W.b.S. 2	29 56	0 11	27. 12	Sleet	W. 3	29 56	
6	Fair and	W.b.S. 1	29 60		9	Fairer		29 62	0 48
12. 12	Cool.	S. 0	29 68		6	Showers	N. W. 1	29 67	0 20
9			29 70		28. 12	of Hail	N.b.w. 2	29 73	
6	Cloudy	S. 1	29 68		9	and Rain		29 83	0 31
13. 12	Warm	S.S.W. 1	29 66		6	Cold	N.w.b.n. 1	29 84	
9	Rain	W.b.S. 0	29 62		29. 12	Showers	N. W. 2	29 86	
6		W.b.n. 1	29 68	0 14	9			29 81	0 43
14. 12	Fair				6		N.N.w. 1	29 78	0 09
9	Showers		29 80	0 06	30. 12	Rain	N.N.E. 1	29 78	
6	Cloudy	W.b.S. 2	29 50		9			29 80	0 25
15. 12		N.n.w. 4	29 50					Total	8 08
9	Showers	N.n.w. 3	29 73						
6	Snow	N. W. 3	29 76						
16. 12		N. 5	29 85						
9	Cloudy	N. 2	29 89	1 00					

M A Y, 1698.

D. h.	Weather.	Winds.	Barom.	Rain.	D. h.	Weather.	Winds.	Barom.	Rain.
6		S. 1	29 74	0 58	6		E. 0	29 66	
1. 12	Rain	N.W. 1	29 73		17. 12	Rain	E. 0	29 63	0 54
9			29 75	0 73	9				
6		N. 2	29 72	0 46	6	Rain	N.E.b.E. 0	29 59	0 43
2. 12	Fair	W.n.w. 1	29 75		18. 12	Warm	S. E. 1	29 56	
9			29 72		9	Fair	S. S. E. 0	29 53	0 05
6	Fair	N. 0	29 75		6	Cloudy	E. 1	29 48	
3. 12	Snow				19. 12	Hot	E. b. E. 2	29 46	
9	Ice				9	Fair	S. 0	29 49	
6	Fair				6	Cloudy	S. e. b. e. 1	29 49	
4. 12	Cold	N.b. E. 2			20. 12	Cooler	S. 4	29 50	
9	Cloudy		29 71	0 22	9	Fair	S. b. W. 2	29 62	
6	Cold	W. 0	29 72		6	Showers	S. S. W. 3	29 68	
5. 12	and	S. W. 1	29 71		21. 12		S. W. b. w. 5	29 73	
9	Fair	S. b. W. 2	29 70		9	Fair		29 81	0 32
6	Rain	S. W. 1	29 66		6	Showers	S. b. E. 1	29 72	0 02
6. 12	Warm	S by E. 1	29 78	0 76	22. 12	and	E. S. E. 1	29 70	
9	Fair				9	Cooler	S. w. b. S. 3	29 66	0 95
6	Cloudy	S. by E. 1	29 78	0 13	6	Rain	S. b. E. 1	29 48	0 79
7. 12		S. by E. 1	29 80		23. 12	Cloudy	S. b. W. 2	29 47	
9	Fair	S. S. E. 0	29 80		9	Fair	S. b. W. 0	29 46	
6	Fair	N. b. W. 1	29 80		6		S. 2	29 43	
8. 12	Warm	N. n. w. 2	29 94		24. 12	Showers	S. W. 0	29 46	0 49
9	Day	N. 0	30 10		9				
6		N. b. W. 1	30 11		6				
9. 12	Same	W. b. S. 1	30 11		25. 12	Fair			
9			30 00		9				
6	Small	W. b. n. 0	29 82		6	Rain			
10. 12	Showers	N. W. 2	29 80		26. 12				
9		W. b. N. 3	29 81	0 08	9	Cool	N. N. e. 2	29 53	2 73
6	Cloudy	N. n. w. 3	29 82	0 03	6	Cloudy	E. b. S. 1	29 67	0 23
11. 12	Cooler	N. n. w. 2	29 85		27. 12	Warmer	S. 1	29 71	
9	Rain	N. N. E. 0	29 82		9	Fair	E. 0	29 78	
6		N. E. 2	29 69	0 51	6	Fair	N. 1	29 78	
12. 12	Showers	N. n. w. 2	29 68	0 10	28. 12	Showers	E. b. N. 1	29 77	
9					9	Rain	E. 1	29 76	0 02
6	Cloudy	N. w. b. n. 2	29 70		6		N. b. E. 1	29 69	1 60
13. 12		N. 3	29 70		29. 12	Miffling	E. b. S. 0	29 74	
9	Fair	N. 0	29 74		9		S. 1	29 76	0 22
6		N. 0	29 75		6		S. b. W. 1	29 70	
14. 12	Fair	E. 2	29 82		30. 12	Fair	N. b. w. 1	29 70	
9			29 87		9				
6		N. E. 4	29 92		6		N. w. b. n. 1	29 68	0 04
15. 12	Fair	N. by E. 1	29 95		31. 12	Fair	W. n. w. 1	29 65	
9		E. by S. 0	29 94		9		W. S. w. 0	29 62	
6	Fair	E. 0	29 87						
16. 12	and							Total	12 03
9	Warm	E. 0	29 73						

Total	8	77
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J U L Y, 1698.

D. h.	Weather.	Winds.	Barom.	Rain.	D. h.	Weather.	Winds.	Barom.	Rain.
6		W.n.w.1	29 78		6	Fair, Fair.	S. W. 1	29 74	0 06
1. 12	Cloudy	W.b.S.1	29 78		17. 12	Cloudy	S. 3	29 77	
9		W.S.w.0	29 75		9	Rain	S.b.W.2	29 73	
6	Cool	N. 1	29 77		6	Misling	S.W.b.w.3	29 51	0 94
2. 12	Rain	N.N.E.2	29 83		18. 12	Rain	S. W. 3	29 56	
9	Warmer	N. 0	29 88	0 23	9	Fairer		29 75	1 12
6	Fair	N. 0	29 88		6		W.S.w.1	29 83	
3. 12	and	S. W. 2	29 86		19. 12	Fair	W.b.n.2	29 87	
9	Hot		29 82		9			29 87	
6	Cloudy	S.w.b.f.3	29 74		6		W.S.w.0	29 84	
4. 12	Misling	S. W. 3	29 67		20. 12	Hot			
9	Rain	S. W. 3	29 61		9				
6		S.b.W.2	29 52	1 87	6				
5. 12	Fairer	W.S.w.4	29 50		21. 12				
9	Rain	S. W. 3	29 56	0 05	9				
6	Cloudy	W.S.w.1	29 66	0 05	6				
6. 12	Hot	S.w.b.w.3	29 70		22. 12				
9	Fair	W.b.S.0	29 75		9				
6	Fair	S.w.b.f.1	29 77		6				
7. 12	Rain		29 76		23. 12				
9	Fair	S. W. 0	29 73		9				
6	Mitty	S. W. 0	29 73		6				
8. 12	Very	W.S.w.1	29 75		24. 12				
9	Hot	S.byE.0	29 78		9				
6	Cloudy	E.b.S.1	29 79		6	Thunder and			
9. 12	Hot and	E. 1	29 78		25. 12	Rain, but			
9	Sultry	E. 0	29 76		9	fair at Tim.			
6		E. 0	29 73			bridge.Wells.			
10. 12	Same	E.b. S. 1	29 72		6				
9		E. 0	29 67		26. 12				
6	Thund. &	E.S.E.1	29 59	2 83	9	Misling	S. W. 2	29 50	4 10
11. 12	Rain, Rain	S.S.W.1			6	Fair	W.b.S.1	29 67	
9	Fairer	S.b.W.0	29 50	0 84	27. 12	and	W. 2	29 78	
6	Cloudy	N.N.w.1	29 48		9	Cooler	W.S.w.0	29 83	
12. 12		W. 2	29 47		6	Fair	S.w.b.1.0	29 86	
9	Rain	N. W. 3	29 47	4 40	28. 12	Cool &	S.b.W.3	29 81	
6	Cloudy	N.N.w.1	29 54	0 01	9	Cloudy	S. 2	29 80	
13. 12		N.w.b.w.2	29 61		6	Rain	S.b.W.3	29 68	0 02
9	Fair	N.w.b.w.0	29 62		29. 12		W.S.w.0	29 76	
6	Cloudy	S.w.b.w.2	29 63		9	Fair	S. W. 0	29 75	
14. 12	with some	S.w.b.w.1	29 63		30. 12				
9	Fair	S.b.W.2	29 58		9	Misling		7 29 41	
6	Cloudy	S.byW.3	29 48		6	Fair	W.b.S.5	29 41	0 10
15. 12	Rain	S. 4	29 43		31. 12	Cooler	W. 4	29 52	
9	Cloudy	S. 2	29 38	0 36	9	Cloudy		29 57	
6	Fair	N. W. 3	29 43					Total	17 03
16. 12	Cool	W.S.w.4	29 53						
9	Rain		29 64	0 47					

AUGUST, 1698.

D. h.	Weather.	Winds.	Barom.	Rain.	D. h.	Weather.	Winds.	Barom.	Rain.
6	Fair	S. W. 2	29 51		6	Fair	N. 0	30 10	
1. 12		W.b.n. 3	29 49		17. 12		N. E. 1	30 09	
9	Showers		29 46	0 13	9	Cloudy		30 05	
6		S.W.b.w. 1	29 43		6		E. 0	29 95	
2. 12	Showry				18. 12	Cloudy	E. 2	29 94	
9		N.b.E. 1	20 55	0 39	9		S. 1	29 85	
6		W.b.S. 0	29 60		6	Fairer	S.S.W. 0	29 82	
3. 12	Fair	N. W. 2	29 62		19. 12	Warm	W.S.w. 2	29 82	
9			29 67		9	Cloudy		29 80	
6	Mistling	S.w.b.w. 1	29 64		6	Cloudy	S. W. 0	29 76	
4. 12	Fairer	W.n.w. 2	29 65		20. 12		S. W. 3	29 73	
9	Rain		29 71		9	Fair		29 67	
6	Fair	W.b.n. 0	29 75	0 14	6	Fair	S.w.b.f. 1	29 59	
5. 12		W.n.w. 2	29 81		21. 12		S.S.W. 2	29 58	
9	Showers		29 87	0 40	9	Cloudy		29 55	
6	Cloudy	W.b.S. 1	29 88		6	Cloudy	S. S. E. 1	29 44	
6. 12	Showers	W.b.S. 3	29 87		22. 12		S. 3		
9	Fair	N. W. 2	29 87	0 05	9	Rain		29 37	0 10
6	Fair	N.w.b.w. 1	29 84		6	Rain	S. 0	29 48	0 48
7. 12	Fair	N.n.w. 2	29 81		23. 12		S.e.b.e. 2	29 51	
9	Fairer	N.n.w. 0	29 80	0 26	9	Thund.		29 47	
6	Misty	W.b.S. 1	29 72		6	Showers	S. by E. 1	29 43	
8. 12	Cool	N.N.E. 1	29 72		24. 12		S. 3	29 42	
9	Rain	N.N.E. 0	29 72	1 57	9	Fair		29 42	0 01
6	Cloudy	S.w.b.w. 1	29 63	0 01	6	Cloudy	S. W. 1	29 41	
9. 12	Dull	S. W. 2	29 61		25. 12		W.b.n. 1	29 42	
9	Day		29 58		9	Fair		29 42	
6		N.w.b.n. 1	29 58		6		E. S.E. 0	29 42	
10. 12	Rain	N. 1	29 61		26. 12	Fair	N. W. 2	29 41	
9		N. E. 0	29 63	1 40	9		N. 1	29 44	
6	Cloudy	N. 1	29 63		6	Fair and	S. W. 0	29 50	
11. 12	Cool	N.b.w. 2	29 65		27. 12	good h.	N. W. 2	29 58	
9	Day	N. 0	29 67		9	weather		29 67	
6		N.b.w. 1	29 69		6		S. W. 1	29 75	
12. 12	Mistling	N. 3	29 70		8. 12	Fair	S. W. 3	29 79	
9			29 76	0 02	9	Rain		29 76	
6	Fair and	N.b.w. 1	29 79		6		W. 1	29 73	
13. 12	Cool.	N. 2	29 84		29. 12	Fair	W.S.w. 3	29 76	
9	Cold	E.b.N. 0	29 90		9	Rain		29 73	0 11
6		N.b.E. 0	29 98		6	Some fair	S. W. 0	29 71	
14. 12	Fair	E. 2	30 01		30. 12	and some	S.S.W. 3	29 75	
9			30 00		9	Rain		29 80	0 35
6	Fair	S.E.b.e. 0	29 95		6	Cool	N. W. 0	29 83	0 02
15. 12	and	N. E. 2	29 96		31. 12	fair with	N.w.b.n. 2	29 85	
9	Warm		29 98		9	Rain		29 84	
6		E. 0	30 00					Total	7 02
16. 12	Same	E.N.E. 2	30 04						
9			30 09						

SEPTEMBER, 1698.

D. h.	Weather.	Winds.	Barom.	Rain.	D. h.	Weather.	Winds.	Barom.	Rain.
6	Cloudy	N.N.W. 0	29 80		6	Rain	E. by N. 0	29 39	
1. 12	Cool	W. 1	29 72		17. 12	Fairer	E. by S. 0	29 36	
9	Day		29 64		9			29 34	1 46
6		S. W. 1	29 52		6	Rain	E. b. S. 0	29 31	
2. 12	Showers	S. W. 3	29 54		18. 12	Fairer	S. E. 1	29 34	
9			29 56	0 14	9			29 36	1 43
6		S.S.W. 1	29 48		6		E.N.E. 1	29 25	
3. 12	Rain	S. W. 5	29 45		19. 12	Showers	S. W. 3	29 25	
9			29 41	2 55	9			29 31	0 65
6	Fair	S. W. 0	29 40		6	Rain	S. W. 1		0 15
4. 12	Rain	S. b. w. 2	29 37		20. 12	Cloudy	S. w. b. w. 2	29 38	
9			29 16	0 20	9	Rain		29 42	
6	Fair	W.S.w. 2	29 13	1 10	6	Foggy	S. W. 0	29 46	0 55
5. 12	Rain				21. 12	Showers	W.S.w. 1	29 48	
9	Fair	S. W. 3	29 48	0 03	9	Fair		29 52	0 01
6	Rain	S. w. b. w. 2	29 50		6	Hoar Fr.	S. w. b. w. 0	29 47	
6. 12	Cloudy	S. W. 4	29 46		22. 12	Fair	S. 2	29 41	
9			29 47	0 09	9	Rain		29 37	0 20
6		S. b. W. 4	29 41		6	Fair	S. W. 1	29 42	
7. 12					23. 12	Warm	W.S.w. 3	29 42	
9					9	Cooler		29 44	
6	Rain				6	Fair	S. S. W. 0	29 44	
8. 12	Fair		29 76	0 77	24. 12	Cooler	S. e. b. e. 1	29 43	
9					9	Cloudy		29 31	
6		S. 0	29 81		6	Rain	S. S. E. 2	29 20	0 42
9. 12	Cloudy	S. b. W. 2	29 80		25. 12				
9		S. b. W. 0	29 80		9				
6	Fog	S. W. 0	29 86		6				
10. 12	Fair	S. b. W. 1	29 89		26. 12	Fair		29 45	0 01
9	Cloudy	W. b. S. 0	29 89		9				
6		S. b. E. 1	29 81		6	Fair and	S. S. E. 1	29 42	
11. 12	Rain	S. b. E. 2	29 79		27. 12	Pleasant	S. 3	29 42	
9		E. b. S. 0	29 31	1 34	9	Rain		29 41	0 11
6	Fair	N. 1	29 86	0 01	6	Fair	S. 0	29 40	0 03
12. 12	Warm	E. 2	29 92		28. 12	Showers	S. 3	29 36	
9	Day		29 87		9	Fair		29 26	0 01
6		E. by S. 0	29 70		6	Rain	E. b. S. 1	29 05	0 04
13. 12	Cloudy	E. b. S. 1	29 61		29. 12	Rain	S. b. E. 3	29 06	
9			29 55		9			29 06	0 76
6		E. 0	29 57		6	Rain	S. by E. 2	29 04	
14. 12	Fairer	N. E. 2	29 62		30. 12	Warm	S. S. W. 4	29 07	
9			29 63		9			29 36	0 40
6	and Fair	E. N. E. 2	29 60					Total	12 07
15. 12	Warm								
9	Cloudy		29 51						
6	Rain	N. e. b. e. 0	29 41						
16. 12	Warm	S. b. E. 2	29 44						
9	Fair		29 46						

OCTOBER, 1898.

D. h	Weather.	Winds.	Barom.	Rain.	D. h.	Weather	Winds.	Barom.	Rain.
7	Misting	S. 3	29 37		7	Ice and	N.N.W. 1	29 62	
1. 12	Warm	S.w.b.f. 4	29 45		17. 12	Fair			
9	Fair		29 66		9	Rain		29 57	0 34
7	Cloudy	S. 2	29 69	0 20	7	Ice	S. 1	29 44	
2. 12	warm &	S. 3	29 71		18. 12	Cloudy	S. W. 2	29 33	
9	Fair		29 77		9	Fair		29 15	
7	Rainy	S. 2	29 83		7	Cold	E.S.E. 2	28 98	
3. 12	Warm	S.S.E. 2	29 83		19. 12		S.b.E. 2	28 84	
9	Day		29 63	2 87	9	Rain		28 83	1 20
7	Fair	S.w.b.w. 1	29 50	1 17	7	Cold	S. W. 2	29 01	0 41
4. 12	Fair		29 50		20. 12	and	W.b.S. 2	29 12	
9	Rain	W.n.w. 7	29 50	0 36	9	Cloudy		29 24	
7	Cloudy	W.n.w. 2	29 82		7	Frost &	N. 0	29 23	
5. 12	Fair	N.b.W. 3	29 88		21. 12	Fair	N. W. 2	29 24	
9	Cooler		29 95		9	Cloudy		29 46	
7		S.w.b.w. 1	30 00		7	Showers	N.N.E. 0	29 50	
6. 12	Cloudy	W.b.N. 2	30 03		22. 12	Hail	S. 2	29 51	
9		W.b.N. 0	30 07		9	Showers		29 57	1 41
7	Cloudy	W. 1	30 07		7	Hard Fr.	S.e.b.e. 0	29 65	
7. 12	Fair	W.b.N. 1	30 07		23. 12	and Fair	E.S.E. 1	29 68	
9	Cloudy	W. 0	30 07		9	Showers		29 70	
7	Fair and	N.W. 0	30 10		7	Fair	E. 0	29 62	0 04
8. 12	somewh.	N.b.W. 1	30 10		24. 12	Warm			
9	Cooler	N. W. 0	30 11		9	Rain		29 58	0 10
7	Cloudy	N. W. 0	30 07		7	Rain	S. 3	29 40	0 11
9. 12	and	W.S.w. 1	30 03		25. 12	Mild	S. by E. 3	29 24	
9	Cooler	S. W. 3	29 88		9	weather		29 42	
7	Rain	W.b.N. 3	29 62	1 55	7	Cloudy	S.S.E. 2	29 48	
10. 12	Fair	W.n.w. 3	29 76		26. 12	Fair and	S.E.b.S. 3	29 47	
9	Rain	S. W. 3	29 61		9	Warm		29 43	
7	Cloudy	W.b.N. 3	29 35	0 03	7	Fair	S.b.W. 0	29 52	
11. 12	Fair	W.b.N. 3	29 36		27. 12	Cloudy		29 52	
9	Cloudy	W.b.N. 3	29 37		9	Rain		29 42	0 80
7	Cloudy	W. 2	29 30		7	Mist	W. 0	29 41	
12. 12	& some	W. 3	29 30		28. 12	fairer	N.N.e. 2	29 24	
9	Rain		29 27	0 23	9	Rain		29 46	0 05
7	Fair	W.b.S. 0	29 14	0 02	7	Cloudy	N.b.E. 2	29 41	
13. 12	Warm	N. 2	29 09		29. 12	Colder	N.b.E. 1	29 41	
9	Cold		29 08		9	Rain		29 41	
7	Fair	W. b. N.	29 20		7	Snow	N.b.E. 4	29 62	1 23
14. 12	Rain	N.b.E. 2	29 30		30. 12	Sleet	N. 3	29 23	
9	Cloudy		29 42	0 07	9	Fairer		29 42	0 29
7	Hoar-F.	N.w.b.n. 0	29 47		7	Hard Fr.		29 62	
15. 12	Fair and	N.w.b.n. 1	29 47		31. 12	Cloudy			
9	Cold		29 47		9			29 76	
7	Icy Frost	N.N.w. 1	29 50					Total	13 08
16. 12	Fair and	N.b.W. 1	29 53						
9	Cold		29 61						

NOVEMBER, 1698.

D. h.	Weather.	Winds.	Barom.	Rain.	D. h.	Weather.	Winds.	Barom.	Rain.
8	Frost	S.w.b.f.2	29 63		8	Frost	S. 0	29 67	0 18
1. 12	Sleet	S. W. 2	29 62		17. 12	and			
9	Cloudy		29 65	0 12	9	Fair		29 37	
8	Fair	S.S.W.0	29 67	0 06	8	Rain	S.E.b.S.2	29 07	
2. 12	Warmer	S. S. w. 1	29 68		18. 12	Fair and	S.w.b.w.2	29 16	
9	Showers		29 64	0 03	9	Cold		29 31	0 04
8	Fair	S. 1	29 55		8	Rain &	S. b. E. 2	29 28	
3. 12					19. 12	Coldthaw	S.w.b.f.3	29 14	
9	Cloudy	S b.W.3	29 49		9	Fair		29 20	0 10
8	Showers	S. 3	29 40		8	Rain	S. W. 2	29 20	0 44
4. 12	Warm &	S. 3	29 30		20. 12	Fair and	S. W. 4	29 27	
9	Cloudy	S. 4	29 15	0 11	9	Warm		29 31	
8	Rain	W.S.w.5	29 98	0 19	8	Rain	S. W. 4	29 14	2 81
5. 12	Fair and	S.w.b.W.6	29 14		21. 12	Fair and	S. W. 3	29 20	
9	Pleasant	S.w.b.W.6	29 37		9	Warm		29 48	
8	Frost	S.w.b.w.0	29 45		8	Frost &	W.b.S.1	29 77	
6. 12	Fair and	S.b.W.0	29 45		22. 12	Fair		29 83	
9	Cold	S.b.W.0	29 43		0	Cloudy		29 75	
8	Rain	S.w.b.w.3	29 22	0 26	8	Rain &			
7. 12	Fair and	W.b.S.4	29 28		23. 12	Warm			
9	Warmer	S.w.b.S.1	29 42		9				
8	Rain	S. 1	29 24		8				
8. 12		W.b.S.2	29 12		24. 12	Rain			
9	Fairer	W.S.w.2	29 27	2 30	9	Stormy		29 75	1 15
8	Fair	S. W. 3	29 33	0 23	8	Some	S.w.b.f.8	29 15	0 61
9. 12	Cloudy	W.S.w.2	29 22		25. 12	Fair	S.W.b.w.8	29 30	
9	Snow	S. S. E. 1	29 27		9	Some Rain	3	29 52	0 15
8	Cloudy	W.S.w.0	29 42	0 36	8		S. W. 4	29 41	
10. 12	Misty	S.w.b.S.1	29 48		26. 12	Rain	S.w.b.w.5	29 33	
9	Day		29 47		9			29 30	0 07
8	Snow and	N.b.E.1	29 48		8	Smaller.	W.S.w.3	29 25	
11. 12	Sleet all	N.b.E.1	29 47		27. 12	and	W.S.w.3	29 27	
9	Snow		29 43	2 66	9	Fair		29 53	
8	Snow 3	N.b.W.2	29 46	2 56	8		W.b.S.1	29 41	
12. 12	Inches.	N.b.W.1	29 54		28. 12	Same	W.b.N.1	29 44	
9	Cloudy		29 65	0 65	9			29 37	
8	Hard Fr.	W.b.S.0	29 60		8	Snow	E.b.N.1	29 13	
13. 12	and	W.S.w.1	29 58		29. 12		E.b.N.2	29 09	
9	Fair		29 62		9	Sleet		29 17	0 74
8	Fair. Snow	W.S.w.1	29 63		8	Frost &	N.b.W.4	29 56	
14. 12	and Hard.	W.b.S.2	29 61		30. 12	Fair	N.N.w.2	29 66	
9			29 70		9	Rain		29 86	0 01
8	Frost	N.N.w.1	29 90					Total	16 83
15. 12	Misty &	W.b.No	29 98						
9	less cold		30 01						
8	Cloudy	S. 1	29 92						
16. 12	Fair	S. S. E. 2	29 92						
9	Thaw		29 81						

DECEMBER, 1698.

D. h.	Weather.	Winds.	Barom.	Rain.	D. h.	Weather.	Winds.	Barom.	Rain.
8	Hard Fr.	N.b.W. 0	29 85		8	Rain	S.b.W. 6	29 09	
1. 12	Fair	E. b. S. 0	29 80		17. 12	Warm	S. by W. 6	29 10	
9	Snow 3		29 78		9	Cloudy		29 22	0 42
8		W.n.w. 0	29 93		8	Cloudy	S.W.b.S. 3	29 32	0 40
2. 12	Foggy	W.b.N. 1	30 01		18. 12	and	S.W.b.S. 2	29 30	
9			30 11		9	Warm		29 34	
8	Cloudy	W.b.S. 0	30 15		8	Fair	S.b.W. 0	29 72	
3. 12	with gentle Thaw	W.b.S. 0	30 16	1 32	19. 12	Cooler	S. b. E. 1	29 67	
9					9	Rain		29 35	
8		W.b.S. 0	30 09		8		S. 3	29 23	0 56
4. 12	Foggy	S. W. 0	30 08		20. 12	Rain	S. b. E. 5	28 98	
9		S.w.b.S. 0	30 06		9			28 68	0 24
8	Fog and	S.w.b. 1. 0	30 02		8	Fair and	W. 4	29 36	
5. 12	Misting	S.b.W. 0	30 03		21. 12	Colder	W. 3	29 52	
9		S. by E. 0	30 00	0 41	9	Rain		29 52	
8	Fog	E. S. E. 1	29 97		8		W.b.S. 4	29 49	0 17
6. 12	Warm	E. 2	29 94		22. 12	Fair	W.S.w. 3	29 55	
9	Clearer	S.e.b.e. 1	29 92		9			29 66	
8	Misty	S. E. 0	29 92		8			29 81	
7. 12	Clearer	S. E. 0	29 91		23. 12	Cloudy			
9	Misty	E. by S. 0	29 88		9		6	29 65	
8	Mist	E. by S. 0	29 83	0 04	8	Cloudy	S. W. 7	29 34	
8. 12	Fair	E. by S. 1	29 86		24. 12	Warm	W.b.n. 8	29 56	
9	Fog	S.w.b.S. 0	29 94	0 12	9	Fair	2	29 82	
8	Rain	S.b.W. 2	29 99	0 03	8		W.b.S. 2	29 94	
9. 12	Cloudy	S.b.W. 3	29 98		25. 12	Fair	W.S.w. 2	29 95	
9	& warm	S.S.W. 4	29 91		9			30 00	
8	Cloudy	S. 6	29 60		8	Cloudy	W.b.S. 3	29 93	
10. 12	Rain	W.b.S. 6	29 64		26. 12	and	W.b.S. 4	29 90	
9	Fair	W.b.S. 2	29 96	0 49	9	Warm		29 77	
8	Fair and	W.S.w. 4	30 10		8	Rain	W.b.S. 4	29 50	
11. 12	Cooler.	S. W. 3	30 14		27. 12	Colder	S.w.b.w. 4	29 43	
9	Cloudy		30 00		9	Fairer			0 21
8	Rain	W.n.w. 3	29 79	0 72	8	Frost &	S. W. 3	29 49	
12. 12	Fair		30 11		9	Frost		29 40	
8	Frost	S.e.b. 1. 0	30 10		8	Warmer	S. W. 7	28 88	
13. 12	Fair	S. S.E. 1	30 06	0	29. 12	Rain	S. W. 8	28 79	
9	Cloudy		29 96		9	Colder		28 69	
8					8	Snow	W.b.S. 3	28 79	0 69
14. 12					30. 12	Frost &	W.b.S. 3	28 89	
9	Rain				9	Fair			
8					8	Frost	W. 0	29 23	
15. 12					31. 12	and	W.n.w. 2	29 36	
9					9	Fair		29 67	
8	Cloudy	S.b.W. 2	29 60	0 01			Total	5 83	
16. 12	Rain	S. 3	29 50						
9	Warm	7	29 44						

XXV.

The Rain
1697 and
1698, at
Townley;
by Mr. Town-
ley, n. 249.
p. 47.

	1697		1698			1697		1698	
Jan.	10	26	12	94	July	27	00	20	74
Feb.	14	34	11	76	Aug.	80	50	43	00
March	9	86	40	32	Sept.	93	80	43	58
April	8	24	41	90	Oct.	55	20	44	52
May	23	76	17	90	Nov.	21	44	49	44
June	17	84	12	90	Dec.	49	00	40	84
					Sum	411	24	379	84

As far as I have learned, the Mercury rises and falls much after the same Measure in most Parts of our Island; and of this you may better judge by some Observations I have here transcribed and sent you, of the very low Stations, *December* 28, about three of the Clock Mercury 28, 17; on the twenty ninth about two Hours and an half 28, 18; and *Jan.* 2, about the same Hour 28, 05, and this time it hardly rise before I went to Bed; and on the sixth still about three Hours 28, 19; but this time before nine at Night it was got to 29, 28. What I note is, that though once I saw it lower many Years ago, yet never since I kept my Observations, did the Quick-silver descend so often to those Pitches; or when it was found very low, did it ever continue so for any considerable time, as it hath done this Year; during which it hath never been very high, and, as I remember, generally much lower than other Years. This hath proved very unseasonable here, and so backward, that I thought I had never known the like; but examining my Observations, I find that of 1673 much what as late, though the Consequence proved not so fatal to these Parts of all *Europe*, as this.

The Weather
1698 and
1699, at
Emuy in
China; by
Mr. Ja. Cun-
ingham, n.
256. p. 323.

XXVI. At *Emuy in China* in the Latitude of $24^{\circ} 20'$ N. *An.* 1698, *Octob.* From 1 to 8, the Weather was fair and clear, the Mercury's Alt. $29\frac{1}{4}$ Dig. From the eighth to the eleventh, close and cloudy Weather, the Mercury falling to $29\frac{1}{2}$ Dig.

11. Close Weather, somewhat cloudy 12. Close Weather, blowing fresh at N. E. 13 and 14. Close and cloudy Weather, with much Rain, and fresh Winds from N. E. to N. W.

The *Tides*, (which commonly flow three Fathoms) did flow above half a Foot higher three Days after the Full-Moon, than it did on the Full-Moon at the *Equinox*.

15. Fair and clear Weather, with small Gales at N. E. From the fifteenth to the twenty fourth, fine, moderate, fair Weather, with small Gales at N. E. to and the thirty first, Winds and Weather variable.

Nov. 1 to 15. Variable, close and cloudy Weather, with some Rain, and variable Gales round the Compass.

15. Fair and clear Weather, with small Gales at N. E. in the Morning the Mercury's Alt. $29\frac{1}{2}$, at Noon $29\frac{1}{4}$, and at ten of the Night being cold, rising

sing to $29\frac{1}{4}$. 16. At Sun-rising very cold, the *Mercury's* Alt. $29\frac{1}{2}$; at Noon fair and pleasant Weather, the *Mercury* falling to $29\frac{1}{2}$; at Night cold, rising to $29\frac{1}{2}$; the Wind at *N. E.* 17. This Morning cold, the *Mercury* at $29\frac{1}{2}$, fair and clear Weather all Day, and at Night blowing somewhat fresh at *N. E.* the *Mercury* at $29\frac{1}{2}$. 18. This Morning cold, the *Mercury* at $29\frac{1}{2}$; all Day fair and pleasant Weather, the *Mercury* falling to $29\frac{1}{2}$, and by Noon to $29\frac{1}{2}$; the Weather fair, somewhat close and cloudy, the Afternoon Sun-shining and warm, and at Night temperate, the *Mercury* continuing at $29\frac{1}{2}$; small Winds at *N. E.* and almost calm.

20. A pleasant Sun-shining Morning, the *Mercury* at $29\frac{1}{2}$; at Noon overcast and cloudy, with little Wind at *N. E.* the *Mercury* falling to $29\frac{1}{2}$; in the Afternoon some Drops of Rain, with close Weather, and at Night the *Mercury* continuing at $29\frac{1}{2}$, with small Westerly Winds; some Rain in the Night. 21. Close and cloudy Weather, with small Gales at *N. E.* the *Mercury* at $29\frac{1}{2}$ in the Morning, and continued so all Day, with some Drops of Rain in the Afternoon, the Gale freshning, and a Shower of Rain at eight of the Night, the *Mercury* rising to $29\frac{1}{2}$. 22. Gray and cloudy Weather all Day, with fresh Gales between *E.* and *N. E.* the *Mercury* at $29\frac{1}{2}$, and at Night rising to $29\frac{1}{2}$; fair Weather, somewhat cloudy. 23. A very cold Morning, fair and clear, with fresh Gales from *N. E.* to *N.* the *Mercury* at 30 Dig. fair and clear all Day, with a moderate Gale about *N. E.* clear and very cold all Night, the *Mercury* continuing at 30 Dig. 24. A fair, clear and cold Morning, the Wind at *N. E.* a moderate Gale, the *Mercury* continuing at 30 Dig. a clear Sun-shining Day, cold and clear all Night, the *Mercury* as before. 25. A sharp, cold Morning, fair and clear, with a moderate Gale at *N. W.* the *Mercury* fallen to 29; all Day fair and pleasant, very warm, and no Wind, the *Mercury* falling at Noon to $29\frac{1}{2}$, and at Night being somewhat hazy and calm withal, to $29\frac{1}{2}$. 26. Temperate Weather all Night, and this Morning somewhat close and hazy, and no Wind, the *Mercury* at $29\frac{1}{2}$, and towards Noon growing clearer and warmer, rising to $29\frac{1}{2}$; small Breezes at *N. E.* at Night falling to $29\frac{1}{2}$, temperate Weather. 27. Fine, pleasant Weather all Day, with small, variable Breezes from the *N.* to *W.* and about to *S.* the *Mercury* in the Morning at $29\frac{1}{2}$, and at Noon falling to $29\frac{1}{2}$ and at Night rising to $29\frac{1}{2}$, fair Weather and calm. 28. Fine, moderate Weather, with a Gale at *N. E.* the *Mercury* at $29\frac{1}{2}$; in the Afternoon the Gale freshned, the Weather somewhat cloudy, and at Night the *Mercury* was at $29\frac{1}{2}$, blowing fresh. 29. Fair and clear Weather, somewhat cold this Morning, with a fresh Gale at *N. E.* the *Mercury* at $29\frac{1}{2}$, fine, pleasant Weather all Day, with small Gales at *N. E.* at Noon the *Mercury* falling to $29\frac{1}{2}$, and at Night being clear and somewhat cold, rising to $29\frac{1}{2}$. 30. Fair and pleasant Weather, with small Gales at *N. E.* the *Mercury* at $29\frac{1}{2}$; at Noon a fresh Gale, the *Mercury* falling to $29\frac{1}{2}$; at Night temperate Weather, and little Wind, the *Mercury* rising to $29\frac{1}{2}$.

Dec. 1. Fine, temperate Weather, with small Gales at *N. E.* the *Mercury* at $29\frac{1}{2}$ in the Morning; fair Weather all Day, and small Breezes at *N. E.* the *Mercury* at Noon falling to $29\frac{1}{2}$, and in the Evening to $29\frac{1}{2}$, and at Night rising to $29\frac{1}{2}$, being fine, clear Weather. 2. Fair and temperate
2 Weather,

Weather, somewhat cloudy, and overcast, with small Gales at *N. E.* The Mercury at $29\frac{1}{2}$, and at Night rising to $29\frac{1}{2}$. 3. A clear and cold Morning, with a fine sharp Gale at *N. b. E.* the Mercury at $29\frac{1}{2}$; a cold Air all Day, the Mercury at Noon falling to $29\frac{1}{2}$, and at Night the Gale freshning made it colder, the Mercury rising to $29\frac{1}{2}$. 4. A sharp Morning, with a fresh Gale at *N. b. E.* the Mercury at $29\frac{1}{2}$; fair and clear all Day, with a small Northerly Gale, the Mercury by Noon falling to $29\frac{1}{2}$; a serene, temperate Night, and almost calm, the Mercury as before. 5. A fine, clear Morning, with a moderate Gale at *S. W.* somewhat cold, the Mercury at $29\frac{1}{2}$; at Noon a small Breeze at *E. b. S.* pleasant Weather, the Mercury at $29\frac{1}{2}$; at Night a small Gale at *S. b. E.* fair and temperate Weather, somewhat hazy, the Mercury at $29\frac{1}{2}$.

6. This Morning somewhat close and cloudy, with a few Drops of Rain, the Weather temperate, with small Southerly Breezes, the Mercury at $29\frac{1}{2}$, the Afternoon calm, and somewhat hazy, the Mercury falling to $29\frac{1}{2}$; at Night overcast and cloudy, with some Rain, blowing fresh at *N.* the Mercury rising to $29\frac{1}{2}$. 7. A gray Morning, clearing up with a fresh Gale at *N. E.* the Mercury at $29\frac{1}{2}$; in the Afternoon the Horizon a little hazy, the Mercury falling to $29\frac{1}{2}$; at Night clearer, with a fresher Gale, the Mercury rising to $29\frac{1}{2}$; a very cold Night. 8. A sharp, clear Morning, with a fine Gale at *N. E.* the Mercury at 30; at Noon falling to $29\frac{1}{2}$, a fine Sun-shining Day; at Night cold and clear, a small Gale at *N. E.* the Mercury rising to 30. 9. This Morning as the last, all Day and Night the same, and the Mercury also.

10. A cold Morning, somewhat foggy, with a fine Gale at *N. E.* the Mercury at 30; all Day fair, clear, and sun-shining; at Night cold, the Mercury at $29\frac{1}{2}$. 11. A cold Morning, with a moderate Gale at *N. W.* the Mercury at $29\frac{1}{2}$; all Day fair and clear, the Mercury falling to $29\frac{1}{2}$; at Night a fresh Gale at *N. E.* the Mercury at $29\frac{1}{2}$. 12. A gray, cold Morning, somewhat cloudy, with a hazy Horizon, a fresh Gale at *N. E.* the Mercury at $29\frac{1}{2}$; towards Noon falling to $29\frac{1}{2}$, with little Wind and fair Weather; at Night calm, and somewhat cold, the Mercury rising to $29\frac{1}{2}$. 13. A fine pleasant Morning, with a small Breeze at *N. W.* the Mercury at $29\frac{1}{2}$; at Noon a small Gale at *N. E.* and in the Afternoon calm, the Mercury falling to $29\frac{1}{2}$; all Day serene, at Night calm, with a clear Sky, somewhat cold, the Mercury rising to $29\frac{1}{2}$. 14. A fine, temperate Morning, with some small Rain like Dew, and a moderate Gale at *S. W.* the Mercury at $29\frac{1}{2}$; the Afternoon a little overcast, and the Horizon somewhat hazy, a small Gale at *S. E.* the Mercury falling to $29\frac{1}{2}$; at Night temperate and calm, the Mercury rising to $29\frac{1}{2}$. 15. A fine, temperate, calm Morning, the Mercury at $29\frac{1}{2}$; at Noon fair, pleasant, calm Weather, the Mercury fallen to $29\frac{1}{2}$; all the Afternoon, and at Night, a fresh Gale at *N. E.* fair Weather, the Mercury rising to $29\frac{1}{2}$. 16. A gray, cloudy Morning, somewhat hazy, with a fresh Gale at *N. E.* the Mercury at $29\frac{1}{2}$; at Noon fair and clear, and Gale moderate, and the Mercury falling almost to $29\frac{1}{2}$; the Afternoon somewhat cloudy, with a fine Gale at *N. E.* at Night a little Wind, serene and sharp, the Mercury rising to $29\frac{1}{2}$. 17. A gray Morning,

Morning somewhat cold, with a fine Gale at *N. E.* the Mercury at $29\frac{1}{2}$, and at Noon falling to $29\frac{1}{4}$; at Night little Wind, the Mercury rising to $29\frac{1}{2}$. 18. A fair, temperate, calm Morning, somewhat foggy, the Mercury at $29\frac{1}{2}$; all Day fair Weather, somewhat cloudy, with small Winds at *N. E.* the Mercury falling to $29\frac{1}{4}$; at Night blowing fresh, the Mercury rising to $29\frac{1}{2}$. 19. A gray, cloudy Morning, with a fresh Gale at *N. E.* the Mercury at $29\frac{1}{2}$; close, thick Weather, with continual Rain all Day and Night, and a moderate Gale at *N. E.* at Night the Mercury rising to $29\frac{1}{2}$. 20. Close, thick, rainy Weather, in the Morning, with a moderate Gale at *N. E.* the Mercury falling below $29\frac{1}{4}$; and by Noon to $29\frac{1}{4}$; continual thick, rainy Weather all Day and Night, the Mercury at $29\frac{1}{4}$, and the Gale as before.

21. A gray, cloudy Morning, but fair, and beginning to clear up, and calm withal, the Mercury at $29\frac{1}{4}$; at Noon fair Weather, and somewhat clear, with a small Gale at *S. W.* the Mercury falling to $29\frac{1}{4}$; at Night calm and somewhat cloudy, the Mercury at $29\frac{1}{4}$. 22. A gray, cloudy Morning, continuing so all Day, with a small Gale at *N. E.* the Mercury at $29\frac{1}{4}$, at Night rising to $29\frac{1}{2}$. 23. A gray, cloudy Morning, continuing so all Day, with small Gales at *N. E.* the Mercury at $29\frac{1}{4}$; at Night more serene, the Mercury rising to $29\frac{1}{2}$. 24. A gray Morning, and calm Weather, the Mercury at $29\frac{1}{2}$; close and cloudy Weather all Day, and no Wind, the Mercury falling to $29\frac{1}{4}$; at Night rising almost to $29\frac{1}{2}$. 25. A gray, cloudy Morning, (some Rain before Day-light) with small *Southerly* Breezes, the Mercury at $29\frac{1}{4}$. Towards Noon Sun-shining and pleasant, little Wind variable, the Mercury falling to $29\frac{1}{4}$; the Afternoon, and at Night, overcast and cloudy, the Wind at *S. b. E.* and the Mercury rising to $29\frac{1}{2}$. 27. A fine, pleasant Morning, with a hazy Horizon, and altogether calm, the Mercury at $29\frac{1}{2}$, and by Noon at $29\frac{1}{2}$; all Day pleasant Weather, and at Night small Gales at *North East*, the Mercury rising to $29\frac{1}{2}$. 28. A fine, pleasant Morning, with a small Breeze at *E. N. E.* the Horizon somewhat hazy, and the Mercury at $29\frac{1}{2}$, at Noon falling to $29\frac{1}{2}$; all Day fair and pleasant Weather, with the aforesaid Breeze; at Night calm, the Mercury falling almost to $29\frac{1}{2}$. 29. A gray Morning, with a close Horizon, and a small Breeze about *E. N. E.* the Mercury at $29\frac{1}{2}$; calm all the Forenoon, in the Afternoon pleasant Weather, with a small Gale at *S. E.* the Mercury at $29\frac{1}{2}$; at Night calm, the Mercury at $29\frac{1}{2}$. 30. A gray, cloudy Morning, and close Weather, with a fresh Gale at *S. E.* the Mercury at $29\frac{1}{2}$; all Day cloudy and dark, the Gale freshning and veering to *E. N. E.* the Mercury rising to $29\frac{1}{2}$. 31. Gray, cloudy Weather all Day, with a fresh Gale at *N. E.* in the Evening some Rain, blowing fresh all Night.

Jan. 1, 1699. Variable Weather, with small Gales at *N. E.* 2. Rainy, thick Weather all Day and Night, with little Wind at *N. E.* 3. Continual thick, rainy Weather all Day and Night, the Wind at *N. E.* 4. Fair Weather, somewhat close, and calm all Day and Night. 5. Close Weather, with some Rain, and calm this Forenoon; and in the Afternoon a small Breeze at *W. N. W.*

D.	h.	Weather.	Winds.	Clouds.	Barom.	Ther.	Rain.	D.	h.	Weather.	Winds.	Clouds.	Barom.	Ther.	Rain.
1.	8	Frost	S.E.b.S.o		29 77			17.	12	Foggy	N.w.b.w.o		30 22	94	
	9	Fair	S.S.E. 1		29 73				5		N. W. o		30 24	100	
	9	Snow			29 43				8	Fog	W. o		30 27	94	
2.	8	Rain	S. 3		29 20		0 63	18.	12						
	9	Warmer	S.b.E. 3		28 76		0 29		5						
	9	and Rain							8	Fog					
3.	8	Same	S. 3	S.b.w.	28 57		0 37	19.	12						
	9		S.b.W. 3		28 47				5				30 34	77	
	8	Cloudy	S.S.W. 3	S.w.b.w	28 44	110			8	Hard Fr.	S. o		30 27	70	
4.	12	Fairer	S. W. 4		28 56	109		20.	12	Fair	S. b. E. 1		30 24		
	9		S. W. 4		28 72	108			5	Foggy			30 21	76	
	8	Frost	S. W. 3		29 22	85			8	Hard Fr.	S. b. E. o		30 18	62	
5.	12	and Fair	S. 1		29 29	94		21.	12	Fog	E.b.N. 1	E.n. e.	30 18	82	
	9	Rain							9	Fair			30 18	81	
	8	Rain	S. o		28 67	104	0 75		8	Frost	E by N. 1		30 16	77	
6.	12	Warm	S. 5		28 61	105		22.	12	and	E.b.N. 2	E.b.N.	30 18	86	
	9	Snow					3 48		9	Fair			30 19	84	
	8	Small Fr.	S. W. 2		29 00	85			8	Cloudy	N. E. 2		30 15	87	
7.	12	Fair	S.w.b.w. 3	S.b.w.	29 08	86		23.	12	Fair					
	9	Rain	S.b.W. o	S. W.	29 19	85	0 03		9	Small Fr.			30 13	81	
	8	Frost	S. W. o	W.f.w.	29 34	85			8	Frost	E.b. N. o		30 13	73	
8.	12	and	W.b.S. 1	S. W.	29 44	88		24.	12	and	E. 2		30 14	88	
	9	Fair			29 70	88			9	Fair			30 12	88	
	8	Hard Fr.			29 72				8	Frost	E. o		30 11	73	
9.	12	and						25.	12	Fair and	E. 1		30 12	86	
	9	Fair			29 73				9	Pleasant			30 09	79	
	8	Same	E. b. S. 1	E.S.E.	29 82	85			8		E. o		30 05	70	
10.	12		S.e.b.e. 2		29 82	89		26.	12	Same	E. 1			88	
	9				29 60				9				29 06		
	8	Rain	S. W. 2	W.f.w.	29 59	101	0 40		8	Frost &	E.N.E. o	E.	29 76	76	
11.	12	Cloudy	S.w.b.w. 2	W.	29 59	99		27.	12	Cloudy	E.b.N. 1		29 72	85	
	9				29 71	102			9	Fair			29 59	76	
	8	Cloudy	S.w.b.S.o		29 69	103			8	Rain	S. E. 2	S.e.b.f.	29 48	89	
12.	12	Mifling	S. W. 2		29 66	109		28.	12	and	E. b. E. 2	S.	29 47	92	
	9	Rain		W.b.f.	29 59	101			9	Thaw			29 66	93	1 51
	8	Fair	S.w.b.w. 3	W.	29 48	93	0 16		8	Frost	S.w.b.f.o	W.b.n	29 86	85	
13.	12	Cloudy	W. b. S. 3	W.b.n	29 42	107		29.	12	Fair	S. 1		29 87	92	
	9	Rain			29 48	93			9	Rain					

FEBRUARY, 1699.

D. h.	Weather.	Winds.	Clouds.	Barom.	Ther.	Rain	D. h.	Weather.	Winds.	Clouds.	Barom.	Ther.	Rain
7	Fair	S. W. 1		29 43	98		7		E. b. N. 0		29 76	93	
1. 12	Pleasant	W. b. S. 2	S. W.	29 53	108		17. 12	Cloudy	E. b. N. 1	W. b. S.	29 82	109	
9	Day	W. b. S. 0		29 77	83		9	Rain			29 83	94	
7	Small Fr.	W. S. w. 0	W. n. W.	29 88	79		7	Fair and	W. n. w. 1		29 84	91	0 09
2. 12	Hazy	S. b. W. 0		29 91	95		18. 12	Pleasant	N. W. 1		29 93	110	
9	Rain	S. 1		29 85	100	0 05	9	Rain			29 80	99	
7	Rain	S. S. E. 3	S. d. E.	29 59	100		7	Fair	W. b. S. 3		29 71	87	0 13
3. 12		S. b. W. 3	S. W.	29 51	105		19. 12	Fair	W. b. n. 4		29 77	104	
9	Fair	S. w. b. w. 1		29 64	92	1 05	9				29 94	90	
7	Small Frost	W. S. w. 1	W. n. w.	29 74	82		7	Frost	W. S. w. 1		30 00	82	
4. 12	Fair	W. 2	N. b. W.	29 80	101		20. 12	and					
9	Cloudy	S. 1	S. W.	29 73	89		9	Fair			29 98	97	
7	Cloudy	S. w. b. w. 3	W. S. W.	29 48	104	0 37	7	Cloudy	W. S. w. 1	W. N. w.	29 94	92	
5. 12	Fair	W. S. w. 3	W.	29 51	113		21. 12	Fairer	W. b. n. 2		29 92	110	
9	Rain	W. b. S. 3	W.	29 48	91		9				29 91	90	
7	Small Fr.	W. b. n. 1		29 76	85		7	Cloudy	W. b. S. 2	W. N. w.	29 81	84	
6. 12	Fair						22. 12	Sleet	N. W. 3		29 72	100	
9	Rain			29 52	93		9	Cold			29 75	79	0 09
7	Violent	W. 8	W. b. N.	28 99	103	1 52	7	H. Frost	N. W. 2		29 83	75	
7. 12	Storms	W. n. w. 10	N. W.	29 22	101		23. 12	Fair					
9				29 78	92		9	Sleet			29 59	86	
7	Cloudy	N. W. 0	N. w. b. n.	29 98	88		7	Cloudy	N. N. w. 0		29 60	92	0 40
8. 12	Fair	S. b. W. 1	N. W.	30 00	101		24. 12	Bluster.					
9	Cloudy			29 88	99		9	Fairer			29 91	85	
7	Misting	W. S. w. 3	W. b. n.	29 79	106		7	Fair	N. w. b. w. 1		29 90	83	
9. 12							25. 12	Cloudy	S. w. b. w. 1	N. W.	29 82	102	
9	Fair			30 07	87	0 20	9	Rain			29 75	96	
7	Hoar Fr.	S. W. 2	N. N. w.	30 02	88		7	Fair	W. 1	W. N. w.	29 77	86	0 08
10. 12	Somewhat	W. 3	N.	30 03	109		26. 12	and	W. b. n. 1		29 83	105	
9	Fair			30 01	95		9	Pleasant			29 77	95	
7	Cloudy	W. b. S. 1	N. W.	29 98	87		7	Rain	W. b. S. 2	W. b. N.	29 64	99	
11. 12		S. W. 2	W. b. N.	29 99	107		27. 12		N. w. b. w. 3		29 67	103	
9	Fairer			29 98	96		9	Fair			29 71	92	0 45
7	Fair	S. W. 2	N. b. W.	29 94	84		7	Cloudy	S. W. 3	W.	29 58	93	
12. 12	Hazy	S. W. 3	N. W.	29 84	102		28. 12						
9	Cloudy Rain	5		29 46	101		9						0 10
7		W. 4	W.	29 34	107	0 01					Total		6 05
13. 12													
9													
7													
14. 12													
9													
7													
15. 12													
9													
7	Rain					1 50							
16. 12	Cloudy	E. b. N. 2	N. E.	29 37	102								
9				29 52	97								

MARCH, 1699.

D. h.	Weather.	Winds.	Clouds.	Barom.	Ther.	Rain	D. h.	Weather.	Winds.	Clouds.	Barom.	Ther.	Rain	
6	Fair						6	Fair	S.	2 S. b. w.	29 84	108		
1. 12	Sleet	N. by E. 2		29 26	86	0 12	17. 12	Hail			30 12	97	0 05	
6	Snow	N. b. w. 3		29 40	82		9	Small Fr.	S. W. 0		30 19	78		
2. 12	Fair			29 64	80	0 04	18. 12	Fair and Pleasant	W. 2		30 22	112		
9							9				30 09	94		
6	Hard Fr.	N. w. b. n. 2		29 72	68		6		S. w. b. f. 3		29 88	98		
3. 12	Fair	W. 1		29 77	96		19. 12	Cloudy	S. W. 4		29 77	115		
9	Cloudy	W. b. S. 1	N. W.	29 78	96		9	Rain			29 60	103		
6	Cloudy	N. b. w. 2	N. N. E.	29 82	93		6	Cloudy	S. w. b. w. 3		29 47	101	0 05	
4. 12	Rain	N. 2		29 91	98		20. 12	Fair	W. b. S. 4	W. S. W.	29 54	118		
9	Cloudy	N. 2		30 02	90	0 02	9	Cloudy			29 48	100		
6	Frost	N. W. 0	N.	30 11	79		6	Fair	S. W. 3	W. b. S.	29 38	99		
5. 12	Cloudy	N. b. E. 1	N. b. W.	30 15	94		21. 12							
9	Fairer	N. b. w. 0		30 19	77		9	Rain			29 49	96	0 15	
6	Hard Fr.	N. N. w. 0		30 11	65		6	Hoar Fr.	W. S. w. 1		29 50	82		
6. 12	Fair	E. 1	N. b. E.	30 07	96		22. 12	Fair	S. W. 2	W.	29 53	113		
9	Cloudy	S. by E. 0		29 95	87		9	Cloudy			29 53	96		
6		S. E. 1	S. b. E.	29 82	82		6		S. b. E. 3	S. b. W.	29 40	101		
7. 12	Fair	S. e. b. f. 2	S. E.	29 83	107		23. 12	Rain	S.	3	29 32	118		
9	Cloudy			29 88	80		9				29 23	113	0 60	
6		E. S. E. 0	N. E. b. e.	29 97	82		6	Cloudy	S. b. W. 2	S. S. W.	29 07	100	0 57	
8. 12	Fair	E. b. N. 2		30 05			24. 12	Fair	S.	4	29 06	119		
9				30 11	85		9	Thunder			29 01	100		
6	Frost	N. E. 0		30 12	80		6	Rain	S. W. 3	W.	29 19	99	0 59	
9. 12	and	E. N. e. 2		30 13	98		25. 12	Cloudy	W.	2	29 31	117		
9	Cloudy			30 14	87		9	Fair			29 38	94		
6		N. b. E. 0	E.	30 10	85		6	Hoar Fr.	S. W. 0		29 39	82		
10. 12	Cloudy	N. b. E. 1		30 11	103		26. 12	Fair	S. b. W. 2		29 41	117		
9				30 08	91		9	Rain			29 46	02	0 25	
6	Small	E. b. N. 0		30 00	86		6	Fair	S.	0	W. S. W.	29 48	86	
11. 12	Rain	S. b. W. 2	S.	29 97	102		27. 12	Rain and	S.	0		29 50	121	
9				29 93	92	0 41	9	Hail			29 54	98	0 41	
6		S. 1		29 84	93	0 18	6	Rain	S. S. E. 0		29 63	92		
12. 12	Cloudy	S. b. W. 1		29 84	106		28. 12		N. N. w. 1		29 71			
9				29 78	97		9							
6	Rain	S. b. W. 1		29 63	93	0 01	6	Fair						
13. 12	Fairer	S. b. E. 1		29 58	102		29. 12	Rain						
9				29 69	88	1 68	9	Fair			29 33	96	0 10	
6	Frost	W. 0		29 80	81		6	Cloudy	W. b. S. 1	W.	29 30	93		
14. 12	Fair						30. 12	Fair	W. S. w. 3		29 23	112		
9	Cloudy			30 84	108		9				29 20	96		
6		S. w. b. S. 2	W. b. S.	29 87	107		6	Cloudy	W. n. w. 4		29 20	99	0 24	
15. 12	Cloudy			30 02	116		31. 12	Fair	N. n. w. 6		29 29	102		
9							9	Rain	N. W. 2		29 43	96		
6	Cloudy	S. W. 1	W. S. W.	30 04	112						Total		5 63	
16. 12	Fair	S. W. 2		30 02	127									
9	Cloudy			29 99	110									

A P R I L, 1699.

D. h.	Weather.	Winds.	Clouds.	Barom.	Ther.	Rain.	D. h.	Weather.	Winds.	Clouds.	Barom.	Ther.	Rain.
6	Rain	W.b.N.1	N. W.	29 37	93		6	Rain	W.S.w.3		29 21	103	
12	and	N. 4		29 39	102		17. 12	Fair			29 25	99	0 21
9	Hail			29 52	98	0 27	6	Hoar Fr.	S. W. 1		29 34	85	
6		N.N.w.3		29 50	92		18. 12	Fair	S. 1		29 34	100	
12	Same	N. 2		29 53	102		9	Rain			29 34	100	
9		N.b.E. 2	N. E.	29 61	95	0 14	6	Fairer	E. 2		29 28	103	0 02
6		N. 2	N.e.b.n.	29 63	88		19. 12	Cloudy	W.b.n. 1		29 42	125	
12	Cloudy	N.e.b.n.3		29 67	108		9	Cloudy			29 65	110	
9		N.b.E. 3	N.e.b.n.	29 79	93		6	Hoar Fr.	W. 0		29 72	89	
6	Fairer	N.b.E. 3	N. E.	29 85	90		20. 12	Fair			29 84	115	
12	Day	N. E. 4		29 90	107		9				29 84	115	
9		N.b.E. 2		29 91	86		6	Mild	S.S.W.1	S. W.	29 87	110	
6	Frost &	N.b.E. 2		29 83	81		21. 12	warm &	S. W. 2		29 94	31	
12	Fair	N. E. 2		29 75	109		9	Fair			29 98	115	
9	Cloudy			29 69	95		6	Cloudy	W.S.w.0	W.	29 99	97	
6		E.b.N. 0	N.	29 55	92		22. 12	Fairer	W.b.S. 2		30 00	130	
12	Cloudy	E. S.E. 1	S.	29 46	112		9				29 97	110	
9				29 43	95		6	Fair	S.W.b.w.2		29 96	104	
6	Cloudy	S.e.b.e. 1	S. E.	29 37	85		23. 12	and	W.S.w.3	N. W.	29 97	131	
12	Cold	E. 2		29 36			9	Pleasant			29 88	113	
9	Fair			29 28	98		6		S.S.w.3	W.S.w.	29 74	109	
6	Cloudy	N. 2		29 17	98		24. 12	Fair			29 60	110	
12	with some	N.b.W.1		29 21	103		9				29 64	102	
9	Drops			29 17	98		6	Fair	S.W.b.w.3	W.	29 37	105	
6	Cloudy	S. 0	N. W.	29 13	97		25. 12	Rain			29 12	109	0 71
12		S. 1	S. W.	29 15	115		9				29 15	123	
9	Rain			29 16	97	0 52	6	Fair	S.w.b.w.4	W.	29 14	100	
6	Fair	S.b.W.0	S. W.	29 23	93		26. 12	Cloudy	W. 4		29 23	92	
12		S. 1		29 31	124		9				29 31	124	
9	Cloudy			29 43	104		27. 12	Rain	S. W. 1		29 41	105	0 07
6		N. 1		29 46	99		9	Cloudy	W.b.S. 1		29 52	89	
12	Rain	N. 3	N. N. E.	29 48			28. 12	Fair	W.b.n. 1	N. b. W.	29 64	122	
9				29 52	101	0 07	9	Drops of	N. 2		29 77	101	
6	Cloudy	N. E. 3		29 59	103	0 35	6	Rain	E. 1	E. b. N	29 81	92	
12		N. E. 4		29 70	113		29. 12	Hoar Fr.	N. E. 0		29 81	129	
9				29 83	99		9	Fair	E. 1	N. b. E.	29 79	104	
6	Cloudy	N. E.		29 90			6	Cloudy	E. 0		29 78	06	
12	Fair			29 86	97		30. 12	Fair	S.by W.1	N.W.b.W	29 79	135	
9	Cloudy			29 82	104		9	Cloudy	N.e.b.w.0		29 81	117	
6	Cloudy	N.e.b.w.3		29 83	121						Total	3 44	
12	Fair	E.N.E.3	E.	29 83	121								
9	Rain			29 76	108	0 12							
6	Cloudy	N.e.b.w.1	E.	29 64	105	0 05							
12	Rain	S. W. 1	S. W.	29 61	118								
9	Fairer			29 61	101	0 97							
6	Cloudy	S.b.W.1		29 58	101								
12		S. 1		29 50	129								
9	Fair			29 36	103								

M A Y, 1699.

D.	h.	Weather.	Winds.	Clouds.	Barom.	Ther.	Rain.	D.	h.	Weather.	Winds.	Clouds.	Barom.	Ther.	Rain.
1.	6		W.b.S. 1	N. W.	29 84	112		17.	6		E.N.E. 3		29 76	113	
	12	Fair	N. W. 1			138			12	Cloudy	N.s.b.s. 3		29 72	137	
	9								9				29 71	113	
2.	6	Fair							6	Fair	N.s.b.n. 2		29 69	115	
	12	Dry							12	and hot					
	9	Rain	S.b.W. 3		29 65	113			9	Day			29 77	124	
3.	6	Cloudy	S.w.b.w. 2		29 47	120	0 34		6		N. 2	N. b. E.	29 80	113	
	12		W.S.w. 3		29 38	133			12	Fair	N.s.b.s. 3		29 83	146	
	9	Showers	W. 3		29 35	106	0 19		9		E. b. S. 0		29 86	115	
4.	6	Fair	S. W. 1		29 34	105			6		N. E. 2		29 86	110	
	12								12	Same	E. b. S. 2		29 86	143	
	9	Rain			29 11	99	0 88		9				29 83	110	
5.	6	Fair	W.b.S. 2		29 17	90			6	Cloudy	N.N.E. 1		29 80	112	
	12	Thund.	S. W. 1		29 31	118			12	Hot and	E.by N. 2		29 76	148	
	9	Rain			29 40	98	0 29		9	Fair	N. E. 3		29 75	120	
6.	6	Hoar Fr.	S.s.w. 1		29 51	92	0 08		6	Fair	N. E. 2		29 72	112	
	12	Fair	S. W. 3		29 58	121			12	Hot and			29 66	115	
	9	Showers			29 69	107	0 01		9	Dry					
7.	6		S.b.W. 0		29 79	98			6	Cloudy	N.s.b.n. 1	N. b. E.	29 66	109	
	12	Fair	S.by E. 2	S.	29 81	137			12		E. 1	N.	29 59	134	
	9				30 87	108			9	Fair	E. 1	W.	29 49	145	
8.	6		S. 1		29 90	102			6	Rain	N.N.E. 3	N. b. E.	29 43	117	
	12	Fair	S. 2		29 93	143			12				29 50	113	
	9								9	Fair			29 50	106	0 01
9.	6	Fair							6	Fair	N.N.w. 2	N. b. W.	29 53	102	
	12	and							12	Hail	N.b.w. 3		29 55	120	
	9	Rain	E. 1		29 93	115			9	Fair	E. b.S. 0		29 57	107	0 01
10.	6		N. E. 1		29 90	92			6	Fair	E. b. S. 1	N. b. W.	29 55	104	
	12	Same	N.b.E. 1		29 88	147			12	Rain	S. W. 2	W. b. S	29 57	132	
	9				29 92	118			9	Fairer	W. 0		29 62	113	0 12
11.	6		N.b.E. 3		30 00	117			6	Fair	S. W. 1		29 65	109	
	12	Same	N. 2		30 10	150			12	Cloudy	S. W. 1	S.	29 67	140	
	9				30 21	108			9	Fair	S. 0		29 66	118	
12.	6	Fair	N.b.W. 2		30 17	105			6	Fair	E. 1	S. E.	29 61	122	
	12	and	N. 4		30 14	132			12	Sultry	E. 2	S.	29 57	150	
	9	Dry			30 10	108			9	Rain	E. 0	E. S. E	29 58	131	
13.	6		N.b.E. 3		30 10	110			6		E. 0	N. W.	29 63	124	0 01
	12	Same	N.N.E. 4		30 08	137			12						
	9				30 06	109			9						
14.	6	Cloudy	N N E. 2		30 05	110			6						
	12		N.b.E. 2		30 02	130			12						
	9	Fair	E. 1	N N E.	30 01	112			9						
15.	6		E.N.E. 1	N. E.	29 99	110			6	Hot and					
	12	Same							12	Dry					
	9				29 92	100			9		W.b.S. 2		30 08	114	
16.	6	Cloudy	N.s.b.s. 2	E. N. E.	29 88	108							Total		2 6
	12	Fair	E.N.E. 3		29 87	131									
	9	Cloudy			29 83	110									

J U N E, 1699.

b.	Weather.	Winds.	Clouds.	Barom.	Ther.	Rain.	D.	b.	Weather.	Winds.	Clouds.	Barom.	Ther.	Rain.
6	Very	S. W. 2	W. b. S.	30 08	132		6							
12	Dry, hot			30 00	138		17. 12							
9	Day			29 91	132		9							
6	Fair	S. W. b. S.	S. W. b. S.	29 85	134	0 01	6							
12	Rain			29 90	123		18. 12							
9		W. 2					9							
6							6							
12							19. 12							
9							9							
6							6	Some						
12							20. 12	Cloudy	W. n. w. 1			29 88	148	3 61
9							9	Some F	W. n. w. 0	N. w. b. n.		29 92	128	
6							6		W. 0	N. N. w		29 95	130	
12						0 01	21. 12		S. 1	N. W.		29 98	163	
9							9							
6	Fair						6							
12	and						22. 12							
9	Dry	W. b. S. 2		29 72	120		9							
6		W. b. S. 3	W. b. N.	29 78	121		6	Fair						
12		W. 2		29 82	142		23. 12	Hot	S. E. 1			29 93	165	
9							9	Day				29 93	141	
6							6	Fair	S. E. 1			29 94	140	
12							24. 12	Sultry	N. by w. 1	W. 1		29 94	165	
9							9	Rain	E. 1			29 93	140	0 20
6	Great						6	Fair	E. 0	W. b. n.		29 89	140	
12	Drought						25. 12	Hot	W. b. S. 1			29 87	166	
9							9	Day	S. w. b. w. 2			29 82	144	
6	Cloudy		N. W.				6		W. 2	W. b. n.		29 76	142	
12		W. b. n. 2	W. b. N.	29 67	146	0 53	26. 12	Fair						
9	Fair	W. 0		29 73	125		9		N. W. 2			29 84	134	
6	Fair	W. by S. 1		29 79	126		6		N. W. 2	N. w. b. n		29 98	130	
12	Hot						27. 12	Same	S. 2	W.		30 01	158	
9	Cloudy	E. 0		29 87	128		9					29 96	135	
6	Hot and	E. 1	W. b. S.	29 86	138		6		W. S. w. 2	W.		29 90	133	
12	Very						28. 12	Same	W. n. w. 2	W.		29 91	161	
9	Dry	E. b. S. 0		29 81	136		9					29 92	125	
6	Fair	E. 1		29 76	131		6		W. n. w. 2			29 96	118	
12		E. b. S. 1	S. E. b. S.	29 71	158		29. 12	Same	W. b. S. 1			29 99	143	
9	Rain	S. 1	S. b. E.	29 70	138	0 04	9					29 99	135	
6		S. S. W. 3		29 86	126		6		N. w. b. w. 1	N. W.		29 99	135	
12		S. b. W. 4	S. w. b. S.	29 92	154		30. 12	Same	N. w. b. w. 3	N.		29 97	162	
9							9		E. 1			30 97	130	
6												Total		4 40
12														
9														
6														
12														
9														

J U L Y, 1699.

D.	h.	Weather.	Winds.	Clouds.	Barom.	Ther.	Rain	D.	h.	Weather.	Winds.	Clouds.	Barom.	Ther.	Rain
1.	6	Misting	N.E.b.E.1		30 00	134		17.	6	Same	E.b.N.0		29 91	138	
	12	Hot and	E.S.E.2	N.	30 00	150			12	Same	E.b.N.2		29 93	167	
	9	Fair			29 97	122			9				29 99	131	
2.	6	Fair	E.S.E.1		29 96	125			6	Cloudy	N.b.E.3		30 03	130	
	12	and	N.E.2		29 92	150		18.	12	Cool	N.2		30 06	142	
	9	Hot			29 87	124			9	Day			30 06	127	
3.	6	Same	E.1		29 83	131			6	Same	N.2		30 01	126	
	12		E.2		29 82	157		19.	12	Same	N.1		29 98	138	
	9				29 78	129			9	Rain			29 92	123	
4.	6	Fair	E.b.N.1		29 74	120			6	Cloudy	N.N.w.2		29 86	115	
	12	Cloudy						20.	12	and	N.w.b.n.2		29 86	139	
	9	Fair	N.E.b.1		29 80	135			9	Cool			29 86	126	0 06
5.	6	Fair	N.2		29 85	123			6	Cloudy	N.N.w.1		29 87	126	
	12		N.2	N.N.E	29 87	150		21.	12		N.N.w.1	N.N.E	29 87	155	
	9	Cloudy			29 90	125			9	Fair	S.4		29 83	134	
6.	6		N.b.E		29 90	120			6	Fair	W.b.S.1		29 81	22	
	12	Cloudy	N.N.E.2		29 90	143		22.	12		N.W.1		29 80	159	
	9				29 86	115			9	Cloudy	S.E.0		29 78	135	
7.	6		N.E.b.n.0	E.b.N.	29 84	120			6	Fair	S.E.1		29 78	131	
	12	Fair	E.1		29 81	147		23.	12	Some	S.2		29 74	172	
	9				29 78	125			9	Drops			29 73	130	
8.	6	Fair	E.b.S.1		29 79	110			6	Fair	S.W.1		29 71	128	
	12	and	W.n.w.1	W.b.N.	29 82	165		24.	12	Rain	S.W.2	W.	29 67	160	
	9	Hot	N.w.b.n.0		29 90	143			9	Fair			29 58	129	0 01
9.	6	Same	N.b.W.1		30 01	132			6		S.S.E.1	S.	29 37	129	
	12		N.w.b.w.1	N.W.	30 03	153		25.	12	Rain	S.1		29 21		
	9				30 04	131			9				29 17	129	1 89
10.	6	Same			30 01	119			6	Fairer	S.1	S.W.	29 21	118	
	12							26.	12	Rain		S.S.W.	29 24	156	
	9		W.		29 88	147			9	Fair	S.2		29 25	129	0 13
11.	6	Hot and	W.b.S.2		29 89	140			6		S.b.W.2	S.w.b.f.	29 11	128	
	12	Dry	W.b.n.2	N.W.	29 89	162		27.	12	Same	S.4	S.S.W.		153	
	9				29 92	143			9				29 18	128	0 1
12.	6	Sultry	E.b.N.0		29 97	140			6	Fair	S.1		29 24	125	
	12	Hot	E.N.E.1		29 97	178		28.	12		S.W.4	S.S.W.	29 27	147	
	9	Cloudy			29 97	143			9	Rain			29 28	129	0 34
13.	6	Very	E.b.S.0		29 99	133			6	Fair	S.b.W.3		29 30	129	
	12	Hot and	E.S.E.1	S.b.E	29 97	173		29.	12	Rain	S.w.b.f.4	S.W.	29 29	148	
	9	Dry			29 90	142			9	thunder			29 35	124	2 11
14.	6	Sultry	E.1		29 87	136			6		S.w.b.f.3	S.W.	29 38	122	
	12	Rain &	E.b.S.2	E.b.N.	29 88	164		30.	12	Fairer	S.W.4		29 42	149	
	9	thunder			29 91	139	0 64		9				29 46	128	
15.	6	Cloudy	N.e.b.n.2		29 93	136			6	Rain	S.S.E.1	S.b.W.	29 36	120	1 04
	12	Fair and	N.E.3		29 90	164		31.	12		S.4		29 34	144	
	9	Dry			29 87	136			9	Fair			29 36	127	
16.	6	Fair	N.E.2		29 87	140									
	12	Hot and	E.2	N.E.	29 88	172									
	9	Dry			29 89	134									
													Total		6 63

AUGUST, 1699.

D. b.	Weather.	Winds.	Clouds.	Barom.	Ther.	Rain.	D. b.	Weather.	Winds.	Clouds.	Barom.	Ther.	Rain.
6	Fair	S. b. W. 4	S. S. W	29 32	128		6	Fair	N. N. W. 1		29 98	108	
12	Rain	S. w. b. f. 4		29 33	145		17. 12						
9	Cloudy	S. W. 8		29 36	130	0 07	9	Cloudy			30 00	116	
6	Fair	W. b. S. 1		29 62	118		6		N. b. W. 1		30 01	110	
12		W. S. w. 1	W. by S	29 70	142		18. 12	Cloudy	N. 2	N. N. E	30 03	138	
9	Cloudy			29 63	131		9				30 02	115	
6	Cloudy	N. N. w. 1	W. S. W.	29 56	123		6		N. 2		29 97	116	
12							19. 12	Cloudy	N. b. E. 2	N. N. E	29 92	142	
9	Fair			29 72	117		9				29 87	124	
6	Cloudy	N. N. w. 0	W. b. S	29 75	105		6	Cloudy	E. N. E. 1		29 82	119	
12	Fair	E. b. S 2	W. b. N.	29 71	147		20. 12	Fairer	N. e. b. n. 2		29 80	140	
9	Rain			29 50	123		9	Cloudy			29 76	127	
6	Rain	E. b. S. 0	S. w. b. 1	29 37	125	4 38	6		N. E. 1	N. b. N	29 70	117	
12		S. W. 1	W.	29 31	139		21. 12	Fairer					
9	Fairer			29 63	127	0 46	9				29 56	129	
6		S. 0		29 07	125		6	Mist	N. N. E. 0		29 50	120	
12	Showry	S. 2		29 59	139		22. 12		W. b. N. 1		29 53	150	
9				29 50	139	0 08	9	Fair			29 59	122	
6	Fairer	S. W. 4		29 39			6	Misty	S. b. W. 0 S.		29 63	118	
12							23. 12	Fair	S. 2		29 64		
9	Rain			29 32	126		9	Cloudy			29 56	128	
6	Fair	S. W. 4		29 30	118	0 75	6	Rain	S. 1	S. b. W.	29 47	129	0 24
12		S. W. 3		29 33	141		24. 12	Cloudy	S. b. W. 3		29 43	148	
9	Rain			29 55	117	0 66	9	Rain			29 37	127	0 21
6		S. W. 2	W. S. W.	29 63	116		6	Cloudy	S. W. 1	W.	29 41	119	
12	Fairer	S. W. b. w. 3		29 66	145		25. 12		S. W. 3		29 53	149	
9				29 69	125		9	Fair			29 64	124	
6	Fair	S. w. b. f. 3		29 70	119		6	Fair	S. W. 1	W. b. S.	29 71	116	
12		S. W. 3		29 72	150		26. 12		S. b. E. 2		29 68	137	
9	Cloudy			29 72	131		9	Rain			29 63	136	0 58
6	Fair	S. 1	S. S. W.	29 65	116		6	Fair	S. w. b. f. 2		29 67	120	
12		S. 3		29 58	152		27. 12		S. w. b. f. 3		29 65	143	
9	Cloudy			29 43	137		9	Cloudy	S. 4	S. S. W.	29 45	128	
6	Rain	N. W. 1	W. b. S	29 49	117		6		S. W. 5	S. w. b. w.	29 48	118	
12	Fair	W. b. n. 3		29 57	140		28. 12	Fair	W. b. S. 5	W. N. w.	29 59	140	
9				29 65	120	0 44	9		W. S. w. 1	W.	29 80	117	
6	Cloudy	S. S. W. 3	N. W.	29 67	120		6	Fair	S. W. 0	W.	29 86	112	
12							29. 12						
9	Rain			29 65	132		9	Rain	S. W. 1		29 89	129	0 12
6	Cloudy	S. W. 2		29 61	131	0 17	6		S. S. W. 2	S. W.	29 89	121	
12		W. b. S. 2	N. W.	29 69	153		30. 12	Fair	S. S. W. 2	S.	29 89	150	
9	Fair			29 73	134		9				29 78	121	
6	Fair	W. S. w. 2	W. b. S.	29 73	139		6	Fair	E. 1		29 60	115	0 01
12		W. S. w. 3		29 72	158		31. 12						
9	Rain			29 75	122	0 44	9	Rain	W. 2		29 73	129	
6		N. W. 1		29 87	110						Total		8 57
12	Fair	N. w. b. n. 2		29 98	132								
9				30 00	111								

SEPTEMBER, 1699.

D.	h	Weather.	Winds	Clouds	Barom.	Ther.	Rain	D.	h	Weather.	Winds	Clouds	Barom.	Ther.	Rain
	6	Mist	S. W. 0		29 84	98			6		E. 0		29 59	112	
1.	12		S.w.b.f. 2	S.	29 85	145		17.	12	Rain	S. W. 1		29 50	141	
	9	Fair	S. 0		29 80	122			9				29 60	116	2 36
	6		S. E. 0	S. by E	29 77	112			6		W.b.s. 2	N. W.	29 82	102	
2.	12	Cloudy			29 77	130		18.	12	Fair	W.n.w. 2		29 83		
	9				29 77	130			9				29 91	106	
	6		S.S.E. 0	S.	29 67	122			6	Rain	S.S.W. 2	W.	29 80	115	
3.	12	Same	N. W. 2	N.w.b. 1	29 65	144		19.	12				29 65	130	0 10
	9				29 72	120			9	Cloudy					
	6		N.E.b.n. 1	S. S. E	29 90	108			6	Rain	S.b.W. 3		29 41	127	
4.	12	Fair	N. 2	N. b.W	29 18	138		20.	12		S.w.b.f. 4	S. b. W	29 42	125	
	9				30 12	115			9	Cloudy			29 36	115	0 34
	6	Mist	N. 0	E.	30 17	96			6	Fair	W.b.w. 3		29 44	106	
5.	12		E. 1		30 18	39		21.	12	Cloudy	S.b.W. 4	W.	29 46	132	
	9	Fairer			30 15	112			9	Rain			29 38	116	0 16
	6	Mist	E. 0		30 07	92			6	Fairer	S. W. 3		29 14	112	2 57
6.	12		E.S. E. 1	E.	30 03	142		22.	12	Rain	S.w.b.w. 4		29 21	128	
	9	Fair			30 01	115			9	Stormy			29 21	116	1 10
	6	Mist	E. 0		30 03	97			6	Fair	S. W. 3		29 05	103	0 27
7.	12	Fair	N. E. 2	N. N. E	30 06	147		23.	12	Cloudy	S.w.b.s. 9		29 07	122	
	9	Cloudy			30 15	131			9	Rain			29 95	102	
	6	Mistling	N.by E. 2		30 21	123			6	Fairer	W.b.S. 2	N.N.W.	29 08	100	0 77
8.	12	Rain	E.N.E. 3	N. E.	30 22	137		24.	12		W.b.S. 3	W. b. N	29 26	121	
	9	Cloudy			30 22	121			9	Rain			29 51	100	1 07
	6		N. 1	N.e.b.n.	30 18	116			6		W.b.S. 1		29 75	88	
9.	12	Fair			30 12	115		25.	12	Fair			30 00	101	
	9								9						
	6		E. 0		30 10	97			6	Mistling	S. W. 1		30 04	102	0 04
10.	12	Fair	E. 2		30 08	142		26.	12		N.n.w. 1	N. b.W.	30 10	120	
	9				30 05	121			9	Cloudy	N.b.w. 0		30 18	121	
	6	Mist	E. 0		29 95	110			6		E. S.E. 0	E. N. E.	30 21	112	
11.	12		E. 1		29 94	150		27.	12	Fair	E.b. S. 2		30 23	123	
	9	Fair			29 91	121			9				30 23	101	
	6		E. 0		29 89	102			6	Fair	N.b.W. 1		30 16	100	
12.	12	Same	E. 1		29 90	152		28.	12	Small	N.b.E. 2		30 12	130	
	9				29 90	127			9	Rain			30 08	117	
	6	Misty	E. 0		29 91	114			6		E. 0	E. N. E.	30 12	117	
13.	12	omewh.	E.b.N. 1	E.	29 93	143		29.	12	Fair	E.b.N. 2		30 12	135	
	9	Cloudy			29 93	129			9		E. N.e. 3		30 11	122	0 24
	6	Misty	E. 0		29 89	126			6		E.b.N. 3		30 08	122	
14.	12	less						30.	12	Cloudy	E. 3	E. b. N	30 10	127	
	9	Cloudy			29 89	127			9		E.b.N. 3		30 08	123	
	6		S. W. 1	S.w.b.w	29 91	122							Total		8 0
15.	12	Same			29 93	134									
	9	very dry													
	6	Rain	S.W. b. S. 0		29 92	128									
16.	12		S.S.W. 1		29 92	140									
	9	Cloudy			29 81	122	0 15								

(99)

OCTOBER, 1699.

h.	Weather.	Winds.	Clouds.	Barom.	Ther.	Rain	D. h.	Weather.	Winds.	Clouds.	Barom.	Ther.	Rain
6	Fair	E. N. 1	E.	29 97	122		6	Fair	E. 1	S. E.	29 50	117	
12		E. 2		29 93	132		17. 12	Fair	E. 1	S. E. b. E.	29 56	130	
9	Cloudy			29 93	123		9				29 61	111	
6	Rain	E. b. N. 2		29 87	118		6		N. E. 2		29 65	118	
12	Fairer	E. b. N. 1		29 80	131		18. 12	Cloudy	E. b. N. 1		29 65		
9	Rain			29 73	111	1 45	9				29 66	119	
6	Fairer	E. b. S. 1	S. S. W.	29 66	115	1 92	6		N. E. 2		29 68	116	
12	Cloudy	S. W. 2		29 67	128		19. 12	Same	E. b. N. 3		29 71	23	
9				29 73	118		9				29 74	114	
6		S. W. 0		29 79	108		6	Cloudy	E. 3		29 75	111	
12							20. 12	and	E. b. N. 3		29 80	111	
9							9	Cool			29 85	39	
6	Cloudy						6		E. 1		29 89	79	
12							21. 12	Frost	E. 3		29 92	120	
9	Fair			29 98	96		9				29 93	83	
6	Hoar F.	N. n. w. 1		30 12	87		6	Frost	S. 0		29 91	73	
12	and	N. 1		30 17	112		22. 12	and	E. b. S. 1		29 91	98	
9	Fair			30 22	89		9	Fair			29 87	79	
6		S. W. 0		30 18	99		6		E. 0		29 77	70	
12	Cloudy	W. b. N. 1		30 19			23. 12	Same	E. b. S. 2	E.	29 77	101	
9	Rain			30 20	96		9				29 70	82	
6		N. E. b. n. 1		30 21	105	0 07	6	Cloudy	E. 1	S. W.	29 51	85	
12	Cloudy	E. b. N. 1		30 20	119		24. 12		S. E. 3	S. w. b. f.	29 32	111	
9				30 16	110		9	Rain			29 07	109	1 95
6		E. 0		30 07	106		6	Fair	S. W. 3		29 18	94	1 04
12	Same	E. b. N. 2		30 06	119		25. 12	Cloudy			29 16	96	
9				30 01	99		9	Rain					
6	Mitt	E. b. N. 0		29 92	92		6		W. 1	N. w. b. n.	29 18	92	0 90
12							26. 12	Fair	N. b. W. 3	N. W.	29 32	110	
9	Fair			29 85	104		9		W. n. w. 0		29 51	88	
6	Mitt	E. 1		29 80	99		6	Frost	W. S. w. 0		29 51	82	
12	Cloudy						27. 12		S. 3		29 42	117	
9	Misting			20 80	120		9	Cloudy	S. W. 1		29 43	111	
6	Mitt	S. e. b. e. 0		29 75	109	0 42	6	Cloudy	S. W. 0		29 51	100	
12	Warm	S. 2		29 77	140		28. 12		S. w. b. f. 1		29 51	114	
9	Fair			20 79	115		9	Rain	E. S. E. 2		29 28	110	1 24
6	Cloudy	S. 0	S. b. W.	29 77	106		6		S. 3		29 08	117	0 31
12	and	S. w. b. S. 3		29 79	136		29. 12	Rain	S. S. E. 2	S.	29 03	122	
9	Warm			29 87	110		9		W. n. w. 3		29 16	96	0 43
6		S. by E. 2		29 78	119		6		S. w. b. w. 2		29 48	89	
12	Same	S. 2		29 81	133		30. 12	Fair			29		
9				29 65	122		9				29 48	100	
6	Cloudy	S. 3	S. S. W.	29 57	129		6	Cloudy	S. 4	S. W.	29 36	115	3 12
12	Misting	S. 2		29 57	136		31. 12				29		
9	Rain			29 54	127		9	Rain			29 14	111	
6		E. S. E. 2	S. E. b. S.	29 52	122						Total		13 49
12	Rain	S. E. 1	S. b. E.	29 48	30								
9				29 50	122	0 64							

NOVEMBER, 1699.

D. n.	Weather.	Winds.	Clouds.	Barom.	Ther.	Rain.
8		W.	3	29	29	95
1. 12	Fair	W.b.N.4	W. S.W.	29	42	103
9	Rain			29	67	99
8		S.W.b.w.0	W. b. S.	29	80	106 0 28
2. 12	Fair	S.b.W.2	S. W.	29	85	116
9	Cloudy			29	84	109
8	Fairer	S.	3	29	53	105
3. 12		S.	6	29	52	119
9	Rain		S.b.W.	29	60	102 0 36
8		S. W.	3	29	85	96
4. 12	Fairer		W. S.W.	29	92	112
9				29	96	111
8	Fair	S. W.	3	29	98	107
5. 12	Cloudy	S. W.	2	30	01	120
9	Fair		W.	30	03	112
8		S. S. E.	0	30	02	100
6. 12	Fair	S. S. E.	1	30	02	115
9			S.	29	97	97
8	Misty	S.S. W.	2	30	02	110
7. 12				30	22	94
9	Fair			30	27	84
8	Misty	W.	0	30	27	98
9		W.	1	30	30	101
8		S.b.E.	1	30	29	100
9. 12	Cloudy	S. E.	1	30	28	107
9				30	22	87
8	Froft &	E.	1	30	16	80
10. 12	Fair	E.	1	30	18	103
9				30	27	92
8		N.	0	30	31	87
11. 12	Foggy	N.byE.	0	30	30	101
9				30	33	96
8	Misty	E.N.E.	0	30	30	94
12. 12		E.b.N.	0	30	30	104
9	Cloudy		S.w.b.S.	30	23	103
8	Cloudy	S. W.	1	30	09	103
13. 12	Fair	S. W.	3	30	03	110
9	Cloudy		W.b.N.	29	85	109
8	Fair	W.S.w.1		29	76	103 0 20
14. 12		W.S.w.4	N. W.	29	70	110
9	Stormy	W.S.w.8		29	36	114
8	Cloudy	W.	6	29	53	109
15. 12		W.b.N.5	N. W.	29	63	115
9	Fair			29	84	94
8		W.b.S.1	W.n.w.	29	87	89
16. 12	Fair	W.S.w.2	W.	29	88	105
9				29	80	113

DECEMBER, 1899.

D.	h	Weather.	Winds.	Clouds.	Barom.	Ther.	Rain.	D.	h	Weather.	Winds.	Clouds.	Barom.	Ther.	Rain.
1.	8	Cloudy	N.N.W. 0		29 71	73		17.	8	Frost & Fair	N. 0		30 25	73	
	12	Hard Fr	N. W. 0		29 71	76			12	Fair	S. W. 1		30 20	88	
	9	Fairer			29 58	60			9	Rain			30 31	90	0 29
2.	8	Frost	E. by S. 3		29 30	78		18.	8	Frost	N. W. 1		30 44	82	
	12	Cloudy	E. 4		29 12	82			12	Hazy			30 35	76	
	9	Snow			28 91	83			9	Fair			30 35	76	
3.	8		E. 3		28 61	91	0 56	19.	8	Cloudy	W. 1	N. W.	30 21	81	
	12	Rain	E. b. S. 3		28 52	94			12	with	N. W. 1		30 20	93	
	9				28 44	100			9	Thaw			30 23	91	
4.	8	Cloudy	E. S. E. 3	S. S. E.	28 60	98	0 18	20.	8	Cloudy	N. W. 0	N.	30 26	86	
	12	Fair			28 74	99			12	Fair	N. W. 1		30 27	102	
	9	Rain			28 74	99			9	Rain	W. n. w. 0		30 31	94	
5.	8		S. b. E. 2	S. b. W.	29 01	99	0 13	21.	8	Misting	N. b. w. 0		30 36	90	
	12	Fair	S. 2	S. S. W.	29 14	110			12		N. b. E. 1		30 40	99	
	9	Rain			29 28	103			9	Fairer			30 47	94	0 03
6.	8	Fair	S. 2		29 26	107	0 74	22.	8	Misting	N. 0	N. E.	30 50	89	
	12	Rain & Warm	S. b. E. 3	S. b. W.	29 32	115			12	Cloudy	N. 1		30 49	92	
	9				29 39	108			9				30 46	85	0 07
7.	8	Cloudy and Warm	S. 1		29 50	100	0 36	23.	8	Frost	N. by W. 0		30 40	74	
	12				29 48	112			12	Fog	N. 0		30 38	88	
	9				29 48	105			9	Cloudy	S. b. E.		30 15	86	
8.	8	Cloudy	S. S. E. 1	S. b. E.	29 37	109		24.	8	Cloudy	S. W. 0		30 21	86	
	12	Misting Warm	S. S. E. 3		29 32	116			12		S. w. b. f. 2		30 19	94	
	9				29 36	114			9		S. S. w. 1		30 15	91	
9.	8		S. E. 3		29 19	113		25.	8	Fairer	S. S. w. 1		30 14	98	
	12	Rain	S. S. E. 3		29 19	117			12		S. w. b. w. 1		30 12	102	
	9				29 29	112	0 38		9	Rain	S. b. W. 1		29 98	102	
10.	8	Fair	S. b. E. 1		29 41	102		26.	8	Cloudy	W. 0	N. w. b. w.	29 96	107	0 68
	12		S. b. E. 2		29 46	112			12	Fair	W. 1	N. W.	30 06	105	
	9				29 57	98			9				30 10	94	
11.	8	Fair	S. W. 0		29 88	92	0 06	27.	8	Fair	W. b. S. 2	N. N. w.	29 95	86	
	12	Cloudy			29 95	108			12	Fair	N. W. 2		29 94	98	
	9	Rain			29 95	108			9		W. b. n. 0	N. b. w.	29 94	91	
12.	8	Cloudy & some Rain	S. b. E. 2	S. b. W.	29 84	109	0 36	28.	8	Fog	W. b. n. 0		29 90	94	
	12		S. 1	S. W.	29 78	115			12	Misting	W. b. S. 0	N. w. b. w.	29 86	108	
	9				29 73	108			9	Rain			29 80	106	0 27
13.	8	Cloudy	S. W. 3		29 54	110	0 61	29.	8	Fair	W. b. n. 2		29 72	96	0 58
	12	Fair	S. W. b. w. 3		29 57	112			12		N. W. 4		29 83	100	
	9				29 63	104			9				30 07	82	
14.	8	Fair	S. W. 1	W. b. S.	29 51	102	0 21	30.	8	Frost	S. W. 2		30 01	89	
	12	Rain	W. b. S. 1		29 43	108			12	Cloudy	S. W. 3	W. by S.	29 96	104	
	9				29 48	98			9	Rain			29 94	105	0 24
15.	8	Fair	W. b. n. 2	N. N. w.	29 64	100		31.	8	Fairer	S. W. 3		29 93	110	0 02
	12	Cloudy	N. n. w. 1		29 69	103			12		S. W. 3		29 92	112	
	9				29 91	99			9	Cloudy			29 95	108	
16.	8	Misting	N. n. w. 1		30 07	95							Total		5 77
	12	Fair	N. 1		30 14	101									
	9				30 27	87									

In these Tables, I have never set down the *Flying of the Clouds*, but when they varied from the Winds; which oftentimes happens, especially before the Wind shifteh its Course: Mountains, &c. may cause some Variation, but as little at *Upminster*, as almost any where. This last Column will be necessary, amongst other Uses, to shew the Reason why the *Mercury* varies sometimes: As suppose the Wind was in the Southerly Points, and the Clouds flew from the Northerly; the Rising of the Mercury would be readily accounted for.

N. 263.
P. 527. My *Thermometer* is graduated by Inches and decimal Parts. The Point of Freezing is about 80, or at most 82 Degrees, and consequently 'tis cold at about 90, and temperate at about 100 Degrees. I need not say, that the Degrees above 100 are warm or hot; and those below 80 are harder Frosts. The Degrees of my *Thermometer* reach to 240, although I could never make the Spirits descend with artificial Freezing, much lower than 50, neither when exposed to the Heat of a pretty strong Sun, did they ascend above 225. It is placed in the open Air, and always defended from the Beams of the Sun. So that it sheweth only the true present Temperature of the Air.

The Winter has been so mild (as appears by the *Thermometer*) that many of the Days of *November* and *December* were not much colder than many of the Mornings and Evenings of the warmer Months. These two last Months have been also much drier than usual, so that had it not been for the Rains of *October*, perhaps a Drought had been a general Calamity.

I have had frequent Confirmations of what I observed last Year, concerning the Mercury rising in foggy Weather. The like it doth also in misting Weather; as may be seen in divers Places of this Table: Particularly *December* 22, the Weather being misting, and Wind Northerly, it ascended to 30,50 Inches, the highest I ever saw at *Upminster*.

Hurricanes
and Storms,
by Mr. J.
Templer, n.
72, p. 2156.

XXVIII. 1. *October* 30, 1669, Between five and six of the Clock in the Evening, the Wind Westerly, at *Ashley* in *Northamptonshire*, happen'd a formidable Hurricane, scarce bearing sixty Yards in its Breadth, and spending it self in about seven Minutes of Time. Its first discerned Assault was upon a *Milkmaid*, taking her Pail and Hat from off her Head, and carrying her Pail many Scores of Yards from her, where it lay undiscovered some Days. Next it storm'd the Yard of one *Sprigg*, dwelling in *Westhorp*, where it blew a Waggon-body off the *Axle-trees*, breaking the *Wheels* and *Axle-trees* in pieces, and blowing three of the *Wheels* so shatter'd over a Wall. This Waggon stood somewhat cross to the Passage of the Wind. Another Waggon of Mr. *Salisbury's* marched with great Speed upon its *Wheels* against the Side of his House, to the Astonishment of the Inhabitants. A Branch of an *Ash-tree*, of that Bigness that two lusty Men could scarce lift it, blew over Mr. *Salisbury's* House without hurting it, and yet this Branch was torn from a Tree an hundred Yards distant from that House. A Slate was forced upon a Window of the House of *Sam. Templer, Esq;* which very much bent an Iron Bar in it; and yet 'tis certain, that the nearest Place the Slate was first forced from, was near

near 200 Yards. At Mr. *Maidwell* Senior, it forced open a Door, breaking the Latch, and thence marching through the *Entry*, and forcing open the Dairy-door, it over-turned the Milk-Vessels, and blew out three Panes or Lights in the Window, next it mounted the *Chambers*, and blew out 9 *Lights* more. From thence it proceeded to the *Parsonage*, whose Roof it more than decimated; thence crosseth the narrow Street, and forcibly drives a Man headlong into the Doors of *Tho Briggs*. Then it passed with a cursory Salute at *Tho. Marston's*, down to Mr. *Geo. Wignil's*, at least a *Furlong's* Distance from *Marston's*, and two *Furlongs* from *Sprig's*, where it plaid notorious Exploits, blowing a large Hovel of *Pease* from its Supporters, and setting it cleverly upon the Ground, without any considerable Damage to the Thatch. Here it blew a Gate-post fix'd two Foot and an half in the Ground, out of the Earth, and carried it into the Fields many Yards from its first Abode.

About half a Mile distant from the Town is a small *Wood* on the Top of an Hill, and partly descending into a Vale encompassed by Northerly and Southerly Hills; so that the Wind may seem confin'd to the Vale as a *Chanel*, before it assaulted the Town, and thereby enforc'd to spend it self only in that *Glade*. But I am unapt to think, that some *Flatus* from the descending Wood-ground might contribute to this Accident, because the Wind continued, so far as Men could judge, as high in the Field afterwards; and the Site of the Town did expose (by reason of those Valleys) a far greater Part of the Town to this Damage than was troubled, the Valley being above four or five times the Breadth of that Part of the Town concerned in it.

2. Oct. 13, 1670. At *Braybrook* in *Northamptonshire*, about eleven a Clock By Mr. J. Temple, p. 2157. the Wind in a strange Form assaulted a *Pease-Reek* in the Field, uncovering the Thatch of it, and leaving another within twenty Yards unconcerned. Thence it proceeded to the *Parsonage*, where it carried not twelve, scarce eight Yards in Breadth, blowing up the End of a *Barley-Reek*, and therewith some Stakes in it of near five Foot long. In the mean while it left a *Wheat-hovel* within six Yards of the *Barley-Reek*, and being without all Shelter, untouched, no Part of the Thatch of the *Hovel* being so much as furl'd. Nevertheless it beat down a *Jack-daw* from the Reek with that Violence as forc'd the Guts out of the Body, and made it bleed plentifully at the Mouth. This I saw, and took up in some Company the Daw very warm. Thence it went in a right Line to the *Parsonage House*, took off the Cover of all the House in its Compass. From hence it passed over the Town without any Damage, the Rest of the Town being low in Situation, and went on to a Place called *Fortbill*, where it uncloathed so much of the Malt-house as lay within its Line and Breadth, so as to expose the Malt upon the Floor to the open Air.

Braybrook stands in a Valley environed by Hills on three Sides, at three Quarters of a Mile's Distance from it. But (what I could chiefly observe) there is an Hill call'd by the Name of *Clackbill*, within a Mile of it, and exactly in that Point of the *Compass* in which the Wind then stood; no Hill in its way till the *Wind* had passed over all the Places it endamaged. And which is remarkable, there have been two Earthquakes in this Town within these ten Years.

Years, when the then gentle Air (or Wind shall I call it) only vibrated upon that Point of the Compass.

By Sir Geo.
Mackenzie,
n. 124. P.
307.

3. Dec. 21, 1674, The *Wind* here (at *Tarbut*) was extraordinary: It broke a Standard-Stone, that stood as an *Obelisk* near an old Church; which Stone was about twelve Foot high, five Foot broad, and near two Foot thick. Whole Woods were overturned, and torn up from the Root, though in a low Situation. It blew from the North-west, and of a long time the Wind had continued Westerly.

By Mr. Scarf-
burgh; n.
231. p. 659.

4. Oct. 19, 1693. There happen'd a most violent Storm in *Virginia*, which stopped the Course of the ancient Channels, and made some where never were any: So that betwixt the Bounds of *Virginia* and *Newcastle* in *Pensylvania*, on the Sea-board side, are many navigable Rivers for Sloops and small Vessels.

By n.
212. p. 192.

5. Aug. 1, 1694. There happen'd here (at *Warrington* in *Northamptonshire*) between one and two a Clock a very terrible *Whirlwind* amongst the Shocks of Corn, in that Part of *Acrement Close*, which is in the Possession of Mr. *Holt*, and took up into the Air about 80 or 100 Shocks, carried a great deal out of Sight; the rest was scattered about the Field, or on the Tops of Houses or Trees thereabouts. I have seen of the Corn which was carried a Mile distant from the Field; and it is reported by Persons of good Credit, that some was carried four or five Miles distant. The *Whirlwind* continued in *Acrement Close* full half an Hour; I my self, and several other Persons, saw at least three or four Waggon Loads of Corn all at once whirled about in the Air.

A Spout at
Topsbam,
near Exeter;
by Mr. Zach.
Maine, n.
215. p. 18.

XXIX. These Appearances are frequent abroad, but very seldom or never seen before with us, tho' some pretend to have seen of them in the *Downs*. The *French* call them *Trombs*, I suppose from the Figure and the Noise that they make, that Word signifying a sort of a *Humming Top*. They are certain Elevations of Water during *Storms* and *Tempests*, reaching from the Superficies of the Sea to the Clouds. They happen several Ways, sometimes the Water is seen to boil, and raise it self for a considerable Space round about a Foot from the Surface, above which appears, as it were, a thick and black Smoke, in the midst of which is observed a sort of Stream or Pipe resembling a Tunnel, which ariseth as high as the Clouds; at other times these Pipes or Tunnels are observ'd to come from the Clouds, and suck up the Water with great Noise and Violence. They move from the Place where they were first gathered, according to the Motion of the *Wind*, and discharge themselves sometimes into the Sea, to the unavoidable Destruction of such Ships as are in their Way, if they be small Vessels, and to their great Damage be they never so big. Sometimes on the Shore beating down all they meet with, and raising the Sand and Stones to a prodigious Height. 'Tis said that Vessels, that have any Force, usually fire their Guns at them loaden with a Bar of Iron, and if they be so happy as to strike them, the Water is presently seen to run out of them with a mighty Noise, but no further Mischiefe.

One of these *Spouts* happen'd here at *Topsbam*, Aug. 7, 1694, between nine and ten of the Clock in the Forenoon; 'twas then very near, if not quite

Low-

Low-Water, which is look'd on as a special Providence, since had it been High-Water, 'tis concluded its Strength would have been much greater, and its Consequences more sad. The Water that was nearest seem'd to fly hither and thither, as tho' it would fain make its Escape from it: Yet I cannot find upon Enquiry, that the Chanel was at all wholly dry. There was also some Wind, tho' not so violent as it had been before; or when the Spout or *Tromb* began to move, it went with the Wind (which was then at *W.N.W.*) like a dark Smoke.

The Marks $+++$ shew the River, O, the Spout, S, Mr. Seaward's House, which is gently toucht with little Damage, blowing only off a few Tiles; G, Widow Goldsworthy's House, which it in part uncovered, and took almost all the Thatch off her Garden Wall. It took off also an Apple-tree, which was no way decayed, and between fifteen and sixteen Inches about, within two or three Inches from the Ground, almost as exactly as any Saw could have done it, and carried it, as I judge, between twenty and thirty Foot from the Place, where it grew, and that not forward in the Path that it took, but almost directly backward, which makes me conclude, that it had a double Motion; the one external from the Wind strait forward, the other internal and circular, like the Fly of a Jack, which a Man may carry in his Hand, that will strike any thing either forward or backward as it meets with it. H, Mr. Green's House, which was for the most Part untild. There were two Houses more, W, L, very much damaged in their Coverings, yet Mr. Moxam's M. tho' it stood between them, and was much higher than either, had only two or three Quarries of Glass broken. EEEEE, shews the March of the Spout. X, Planks that were blown, some upright, some several Yards out of their Place. D, a Ship newly lanch'd, of about one hundred Tuns, which was much shaken, but not hurt. K, a Mast of near a Tun Weight, thrown out of its Place. C, an Anchor that was torn out of the Ground, and carried seven or eight Foot with a Boat that was fasten'd to it, and blown up into the Air; that Boat was rent from the Head to the Keel. B, another new Boat blown about six Foot high, and turned upside down. F, a Fishboat with one Man in it, which was near the Place where the Spout was at first perceived, but through Mercy escaped. P, a Lane that goes from the River in which some Houses suffered Damage, which shews that the Spout was divided in its March. 'Tis no small Mercy that no Man, Woman, or Child received the least Injury in their Persons.

Fig. 19.

XXX. 1. John Gill affirms, that he hath observed on several Occasions, that being in a Calm, that Way which the Sea began to loom or move, the next Day the Wind was sure to blow.

Prognosticks
of the Wind;
by J. Gill, n.
26. p. 481.

2. It hath been the Custom of our English and French Inhabitants of the Caribbee Islands, to send in, about the Month of June, to the native Caribbees of Dominico and St. Vincent, to know whether there would be any Hurricanes that Year; and about ten or twelve Days before the Hurricane came, they did constantly send them Word, and it very rarely or seldom failed. From one of these Indians, (whom in 1657 I engaged by Civilities to remain with me several Years,) I had the following Prognosticks.

Prognosticks
of Hurri-
cane; by
Capt. Lang-
ford, n. 246.
p. 407.

1. All Hurricanes come either on the Day of the Full, Change, or Quarter of the Moon.

2. If it will come on the Full-Moon, you being in the Change, then observe these Signs.

That Day you will see the Skies very turbulent, the Sun more red than at other Times, a great Calm, and the Hills clear of Clouds or Fogs over them, which in the *Highlands* are seldom so. Likewise in Hollows, or Concaves of the Earth, or Wells, there will be a great Noise, as if you were in a great Storm, and at Night the Stars looking very big with Burs about them, and the North-west Sky very black and foul, the Sea smelling stronger than at other Times, as usually it doth in great Storms, and sometimes that Day, for an Hour or two, the Wind blows very hard Westerly, out of his usual Course.

On the Full of the Moon you have the same Signs, with a great Bur about the Moon, and many times about the Sun.

The like Signs must be taken notice of on the Quarter Days of the Moon, in the Months of *July*, *August*, and *September*; for the Hurricanes come in those Months; the soonest that I ever heard of was the twenty fifth of *July*, and the latest was the eighth of *September*; but the usual Month they come in is *August*.

The Benefit I have had of foretelling these Hurricanes is, that whereas heretofore they were so dreadful, that all Ships were afraid to go to Sea, and did rather chuse to stay in the Roads at Anchor, than to run the Hazard of the merciless Sea, altho' never Ship escaped at Anchor, but was cast ashore, many times by the Violence of the Storm, some Vessels have been cast so far on the Shore, that when the Storm was over, they have been from twenty or thirty Yards dry from the Wash of the Shore, and the Vessels set whole; and by this means the Lives of those that were in those Vessels were saved. But I finding that if a Man keeps his Ship sailable, with good Store of Ballast, his Ports well barr'd and calked, his Top-masts down, and his Tops too if he have Time, his Yards a-port laced, or long Ships, keeping secure his Doors and Windows of his Ship, and she will lie as well as in other Storms, and they may, having their Ships in a Readiness, stay in the Road till the Storm begins, which is always first at North, so to the North-west, till he comes round to the South-east, and then his Fury is over. So with the North Wind they may run away to the South, to get themselves Sea-room for drift of the South-west Wind where he blows very fiercely; by these Means I have, by God's Blessing, preserved my self in two Hurricanes at Sea, and in three at Shore, in the Years 1657, 1658, 1660, 1665 and 1667, those at Sea I lost not a Sail, Yard, or Mast, they being two great Hurricanes. And in the Year 1667, I being on Shore at *Nevis*, there was a Hurricane on the nineteenth Day of *August*, and fourteen Days before I did take notice of the foregoing Signs on a full Moon, and I acquainted Sir *John Berry*, who was Commander of his Majesty's Ship *Coronation*, and several other Commanders there, who did make their Ships ready for the Sea; and in the Morning about four of the Clock, the Wind coming hard Northerly, they

they put to Sea; and by God's Blessing came all back in four or five Days time safe to the Road again. On the Shore, being confident of the Hurricane's coming, I took such Care before-hand to secure my Sugars and Goods in the Store-house, that when the Hurricane had carried away the Roof of the House, all except one Hoghead of Sugar remained safe.

The Reasons and Causes of these violent Storms, according to my Judgment, may be these:

1. It is not unknown to all Men of Experience, that to the Southward of the *Tropick* there is constantly a *Trade-Wind*, or Easterly Wind, which goes from the North to the South-East all the Year about: except where there are Reversions of *Breezes*, and Inlets near the Land; so that when this Hurricane, or rather Whirlwind, comes in Opposition to the constant Trade-wind, then he pours down with that Force and Violence, that it exceeds all Storms of Wind in the World; for he takes Trees away by the Roots, and those that are extraordinarily strong rooted, he twists off in the middle: In the Hurricane in 1667, at *Nevis*, I saw the high Mountain that was all green with Trees, left in most Places bare, and the Wood lying in such a Condition, with half Trees, or Stumps, or Quarters, that one would think it almost incredible.

2. It is remarkable by all Men that have been in those Parts where the Sun comes to a *Zenith*, that at his Approach towards the *Zenith*, there is always fair Weather; but at his Return to the Southwards, it occasions off the North Parts of the *Equinoctial* generally much Rains and Storms, as *Tornado's*, and the like, which makes the Winds in the *Tornado's* to come on several Points. But before it comes, it calms the constant Easterly Winds; and when they are past, the Easterly Wind gathers Force again, and then the Weather clears up fair.

3. The Wind being generally betwixt the *Tropicks* Easterly, unless at such Times as before declared, meeting with the Opposition of these *Hurricanes*, which comes in a contrary Course to that *Trade-Wind*, doth cause this violent *Whirlwind*, on the Sun's leaving the *Zenith* of *Barbadoes*, and those adjacent Islands; by which the Easterly Wind doth much decay of his Strength; and then the West Wind, which is kept back by the Power of the Sun, doth with the greater Violence and Force pour down on those Parts where he encroaches. And it is usual in our sailing from *Barbadoes*, or those Islands, to the North for a Westerly Wind, when we begin to lose our Easterly Wind to have it calm, as it is before *Hurricanes*: And then the Wind springing up, causeth it till it comes well settled, to be various; but after the settled Westerly Wind comes fresh, we have been constantly without those Shufflings from Point to Point.

Here it is to be observed, that all *Hurricanes* begin from the North to the Westward, and on those Points that the Easterly Wind doth most violently blow, doth the *Hurricane* blow most fiercely against it; for from the *N. N. E.* to the *E. S. E.* the Easterly Wind bloweth freshest; so doth the *W. N. W.* to the *S. S. W.* in the *Hurricane* blow most violent; and when he

comes back to the S. E. which is the common Course of the *Trade Wind*, then he ceaseth of his Violence, and so breaks up. So, with Submission to better Judgments, I take the Cause of *Hurricanes* to be the Sun's leaving the *Zenith* of those Parts towards the South. And Secondly, the Reverse or Re-bounding back of the Wind, which is occasioned by the calming of the *Trade Wind*.

But it will be objected, Why should not this Storm be all over those Parts of the *West-Indies*, as well as *Barbadoes* and the *Leeward-Islands*? To which I answer, That it hath, in about twenty five Years of my Experience, taken its Course from *Bermudas* or *Summer-Islands*, to the *Caribbee-Islands*; but seldom or never doth he carry such a Breadth, as from the Latitude of 16 to 32 Degrees, which are the Latitudes of the one and the other Place; but it hath been observed, that when *Hurricanes* have been in *Martinico*, which is within two Degrees of Latitude, and two Degrees of Longitude, according to the Miles of that Circle, yet no *Hurricane* hath been in *Barbadoes*; nor could I ever call any of the former Storms at *Barbadoes* *Hurricanes*, till that in 1675. Again, it hath been noted, that *Hurricanes* have done the like to the Northwards: For when the *Hurricane* hath been in *Antegoa* and *St. Christopher's*, those Ships that were but in the Latitude of twenty Degrees had no *Hurricane*, but constant Westerly Winds reasonably fair, and then there were no *Hurricanes* in *Bermudas*; and when the *Hurricanes* were at *Bermudas*, the *Leeward* or *Caribbee Islands* had no *Hurricane*; nor had those Islands the *Hurricane* when *Barbadoes* had it.

It may well be further objected, Why the *Hurricane* was never known to go farther to the Westward than *Porto Rico*, which lies in or near the Latitude of those Islands of *St. Christopher's*? To this I answer, That from *Porto Rico* downwards, both that Island as well as *Hispaniola*, and other Islands there adjacent, are of vast Greatness, and very high Lands, that of themselves doth most commonly give Reversal or Westerly Winds at Night, through the Year: For there, for the Reasons aforesaid, the Easterly Wind, towards Night doth calm, and those Lands afford a *Land Wind*, which the other Islands cannot do, by Reason of the Smallness of those *Caribbee Islands*, but very near the Shore, the *Trade-Wind* having his full Power till this General *Whirl-Wind* comes for the Reasons aforesaid.

I do imagine so likewise to the Southwards of *Barbadoes*, where the *Tornadoes* come frequently, there is no *Hurricanes*; neither was there at *Barbadoes*, when these *Tornadoes* did commonly come there, which made some small Reversal, though it was but for two or three Hours: Yet the Easterly Wind, giving some way by the Sun's declining from that *Zenith*, doth prevent this furious Reverse, where it hath no Vent, till by the Violence of the two *Winds* it is forced.

An Experiment of the Evaporation of Water; by Mr. Edm. Halley, n. 189. p. 366.

XXXI. We took a Pan of *Water* (salted to the same Degree as is common *Sea-Water*, by the Solution of about a fortieth Part of Salt) about four Inches deep, and 7 Inches $\frac{2}{3}$ Diameter, in which we placed a *Thermometer*, and by means of a Pan of Coals, we brought the *Water* to the same Degree of Heat which is observed to be that of the Air in our hottest Summers; the *Thermometer*

meter nicely shewing it. This done, we affixed the Pan of *Water*, with the *Thermometer* in it, to one End of the Beam of the Scales, and exactly counterpoised it with Weights in the other Scale; and by the Application or Removal of the Pan of Coals, we found it very easy to maintain the *Water* in the same Degree of Heat precisely. Doing thus, we found the Weight of the *Water* sensibly to decrease; and at the End of two Hours we observed, that there wanted half an Ounce *Troy*, all but 7 Grains, or 233 Grains of *Water*, which in that time had gone off in Vapour; tho' one could hardly perceive it smook, and the *Water* were not sensibly warm. This Quantity in so short a time seemed very considerable, being little less than 6 Ounces in 24 Hours, from so small a Surface as a Circle of 8 Inches Diameter. To reduce this Experiment to an exact *Calculus*, and determine the Thickness of the Skin of *Water* that had so evaporated, I assume the Experiment alledged by Dr. *Edw. Bernard* to have been made in the *Oxford Society*, viz. that the Cube Foot *English* of *Water* weighs exactly 76 Pounds *Troy*; this divided by 1728, the Number of Inches in a Foot, will give $25\frac{3}{4}$ Grains or half Ounce $13\frac{1}{4}$ Grains for the Weight of a Cube Inch of *Water*; wherefore the Weight of 233 Grains is $\frac{233}{13\frac{1}{4}}$ or 35 Parts of 38 of a Cube Inch of *Water*. Now the Area of the Circle, whose Diameter is $7\frac{2}{5}$ Inches, is 49 square Inches; by which dividing the Quantity of *Water* evaporated, viz. $\frac{1}{3}$ of an Inch, the Quote $\frac{1}{147}$ or $\frac{1}{147}$, shews that the Thickness of the *Water* evaporated was the 53d Part of an Inch: But we will suppose it only the 60th Part, for the Facility of Calculation. If therefore *Water* as warm as the Air in Summer, exhales the Thickness of a 60th Part of an Inch in two Hours from its whole Surface, in 12 Hours it will exhale $\frac{1}{5}$ of an Inch; which Quantity will be found abundantly sufficient to serve for all the Rains, Springs, and Dews, and account for the *Caspian Sea's* being always at a Stand, neither wasting nor overflowing; as likewise for the Current said to set always in, at the *Streights* of *Gibraltar*, tho' those *Mediterranean Seas* receive so many, and so considerable Rivers.

To estimate the Quantity of *Water* arising in Vapour out of the Sea, I think I ought to consider it only for the Time the Sun is up, for that the Dews return in the Night as much, if not more Vapours than are then emitted; and in Summer the Days being longer than twelve Hours, this Excess is balanced by the weaker Action of the Sun, especially when rising before the *Water* be warmed: So that if I allow $\frac{1}{5}$ of an Inch of the Surface of the Sea to be raised *per diem* in Vapours, it may not be an improbable Conjecture.

Upon this Supposition, every 10 Square Inches of the Surface of the *Water* yields in Vapour *per diem* a Cube Inch of *Water*; and each Square Foot half a *Wine Pint*; every space of 4 Foot Square, a Gallon; a Mile Square, 6914 Tons, a Square Degree, suppose of 69 *English* Miles, will evaporate 33 Millions of Tons: And if the *Mediterranean* be estimated at 40 Degrees long and 4 broad, Allowances being made for the Places where it is broader by those where it is narrower, (and I am sure I guess at the least) there will be 160 Square Degrees of Sea; and consequently the whole *Mediterranean*

terranean must lose in Vapour, in a Summer's Day, at least 5280 Millions of Tuns. And this Quantity of Vapour, though very great, is as little as can be concluded from the Experiment produced: And yet there remains another Cause, which cannot be reduced to the Rule, I mean the *Winds*, whereby the Surface of the *Water* is lick'd up, somewhat faster than it exhales by the Heat of the Sun, as is well known to those that have considered those drying *Winds* which blow sometimes.

The *Mediterranean* receives these considerable Rivers; the *Iberus*, the *Rhone*, the *Tiber*, the *Po*, the *Danube*, the *Neister*, the *Borysthenes*, the *Tanais*, and the *Nile*, all the rest being of no great Note, and their Quantity of *Water* inconsiderable. We will suppose each of these nine Rivers to bring down ten times as much Water as the River *Thames*, not that any of them is so great in Reality, but to comprehend with them all the small Rivulets that fall into the Sea, which otherwise I know not how to allow for.

To calculate the Water of the *Thames*, I assume that at *Kingston Bridge*, where the Flood never reaches, and the Water always runs down, the Breadth of the Chanel is 100 Yards, and its Depth 3, it being reduced to an Equality, (in both which Suppositions I am sure I take with the most.) Hence the Profile of the Water in this Place is 300 Square Yards: This multiplied by 48 Miles, (which I allow the Water to run in 24 Hours, at 2 Miles in an Hour) or 84480 Yards, gives 25344000 Cubick Yards of Water to be evacuated every Day, that is, 20300000 Tons *per diem*; and I doubt not but in the Excess of my Measures of the Chanel of the River, I have made more than sufficient Allowance for the Waters of the *Brent*, the *Wandel*, the *Lea*, and *Darwent*, which are all worth notice, that fall into the *Thames* below *Kingston*.

Now if each of the aforesaid nine Rivers yield ten times as much Water as the *Thames* doth, 'twill follow that each of them yields but 203 Millions of Tons *per diem*, and the whole nine but 1827 Millions of Tons in a Day; which is but little more than $\frac{1}{3}$ of what is proved to be raised in Vapour out of the *Mediterranean* in twelve Hours time.

The Evaporation of Water in a Close Room at Gresham Coll. 1693. by Mr. Edm. Halley, n. 212. p. 183.

XXXII. In order to explain the Circulation of Vapour experimentally, I caused an Experiment of the Quantity of Vapours arising simply from the Warmth of the Water, without being exposed either to Sun or Wind, to be made in *Gresham Coliege*, which was performed with great Care and Accuracy, by Mr. *Hunt*, Operator to the *Royal Society*. Having added up into one Sum the Evaporations of the whole Year, I find, that from a Surface as near as could be measured of eight Square Inches, there did evaporate during the Year, 16292 Grains of Water, which is 64 Cube Inches of Water, and that divided by eight Inches, the Area of the Water's Surface, shews that the Depth of Water evaporated in one Year amounts to eight Inches. But this is much too little to answer to the Experiments of the *French*, who found that it rained nineteen Inches Water in a Year at *Paris*; or those of Mr. *Townley*, who by a long continued Series of Observations,

vations, has sufficiently proved, that in *Lancashire*, at the Foot of the Hills, there falls above forty Inches of Water in the Year's time. Whence it is very obvious, that the Sun and Wind are much more the Causes of Evaporation, than any internal Heat or Agitation of the Water.

The same Observations do likewise shew an odd Quality in the Vapours of Water, which is that of adhering to the Surface that exhaled them, which they clothe as it were with a *Fleece* of vaporous Air, which once investing it, the Vapour rises afterwards in much less Quantity: which was shewed by the small Quantity of Water that was lost in twenty four Hour's time, when the Air was very still from Wind, in proportion to what went away when there blew a strong Gale, altho' the Experiment were made in a Place as close from the Wind as could be well contrived. For which Reason I do not at all doubt, that had the Experiment been made where the Wind had come freely, it would have carried away at least three times as much as we found, without the Assistance of the Sun, which might perhaps have doubled it.

By the same Experiment it likewise appears, that the Evaporations in *May*, *June*, *July*, and *August* (which are nearly equal) are about three times as much as what evaporated in the four Months of *November*, *December*, *January* and *February*, which are likewise nearly equal, *March* and *April* answering nearly to *September* and *October*.

This *Fleece* of Vapour in still Weather hanging on the Surface of the Water, is the Occasion of very strange Appearances, by the Refraction of the said Vapours differing from that of the common Air, whereby every thing appears raised, as Houses like Steeples, Ships as on Land above the Water, and the Land raised, and as it were, lifted from the Sea, and many times seeming to overhang. And this may give a tolerable Account of what I have heard of seeing the Cattle at high Water time, in the Isle of *Dogs* from *Greenwich*, when none are to be seen at low Water (which some have endeavour'd to explain, by supposing the Isle of *Dogs* to have been lifted by the Tide coming under it. But the evaporous Effluvia of Water having a greater Degree of Refraction than the common Air, may suffice to bring those Beams down to the Eye, which when the Water is retired, and the Vapours subsided with it, pass above, and consequently the Objects seen at the one time, may be conceived to disappear at the other.

JANUARY 1693				FEBRUARY 1693.			
D.	Grains.	Ther.	Barometer. Weather.	D.	Grains	Ther.	Barometer. Weather.
1	31 $\frac{1}{2}$	5	29. 7 Frost.	1	36	29	30. 0
2	21	14	29. 7 Some Rain.	2	27	26	30. 2
3	21	18	29. 7	3	33	25	30. 2.
4	23 $\frac{1}{2}$	8	29. 7	4	48	16	29. 9
5	23 $\frac{1}{2}$	8	30. 1	5	39 $\frac{1}{2}$	20	29. 9 Some Rain.
6	26 $\frac{1}{2}$	1	30. 5 Frost.	6	26	16	29. 9 Small Rain.
7	31	— 3	30. 5 Frost.	7	26	17	29. 8
8	25	— 5	30. 4 Frost.	8	28	11	29. 9 A Fogg.
9	23	— 3	30. 4 Frost.	9	23	16	30. 0
10	18	0	30. 4	10	26	20	30. 0
11	18	0	30. 4	11	39	8	30. 0
12	18	— 0	30. 4	12	40	5	29. 8
13	22	— 6	30. 3 Frost.	13	52	— 1	29. 4 High Wind.
14	20 $\frac{1}{2}$	— 7	30. 3 Frost.	14	35	6	29. 2
15	21 $\frac{1}{2}$	— 10	30. 3 Frost.	15	35	11	29. 4 Some Rain.
16	24	— 15	30. 4 Frost.	16	24	20	29. 2 Rain.
17	18	— 13	30. 3 $\frac{1}{2}$ Frost.	17	39	20	29. 5 Rain.
18	18	— 11	30. 2 Frost.	18	39	19	29. 8
19	14	— 10	30. 1 Frost.	19	35 $\frac{1}{2}$	17	29. 7
20	14	— 3	29. 6	20	35 $\frac{1}{2}$	16	29. 3
21	21	0	29. 9	21	35	17	29. 0 Rain.
22	18	2	39. 9	22	29	10	29. 2
23	18 $\frac{1}{2}$	0	30. 0 Frost.	23	35	5	29. 3
24	18 $\frac{1}{2}$	— 3	30. 0 Frost.	24	37	1	29. 2
25	14 $\frac{1}{2}$	9	29. 9	25	35	— 5	29. 4
26	14 $\frac{1}{2}$	14	29. 7	26	23 $\frac{1}{2}$	— 8	29. 0 Snow.
27	20	17	29. 2	27	21	— 11	29. 4 Frost.
28	36	10	29. 7	28	24	— 14	29. 3 Frost.
29	27 $\frac{1}{2}$	15	29. 5 Some Rain.				
30	27 $\frac{1}{2}$	15	29. 7				
31	27	27	29. 6				
	675 Grains.				690 $\frac{1}{2}$ Grains.		

MARCH, 1693.					APRIL, 1693.				
D.	Grains.	Ther.	Barometer.	Weather.	D.	Grains.	Ther.	Barometer.	Weather.
1	25	—12	29.2	Frost.	1	32	15	29.4	
2	31 $\frac{1}{2}$	—12	29.1	Show.	2	39	15	29.5	
3	28	—13	29.3	Show, Frost.	3	37 $\frac{1}{2}$	14	29.7	
4	28	—12	29.6	Frost.	4	37	23	29.6 $\frac{1}{2}$	
5	28	—8	29.3	Frost.	5	38	29	29.2	
6	20	—1	29.1		6	29	32	29.2	
7	35 $\frac{1}{2}$	5	29.3	Rain.	7	32	33	29.3	
8	39	9	29.7		8	32	35	29.4	
9	42 $\frac{1}{2}$	8	30.0		9	28 $\frac{1}{2}$	40	29.2	
10	39	14	30.0		10	35	33	29.4	
11	33	21	30.0		11	37	33	29.4	
12	42	21	29.8		12	34	37	28.9	
13	42	22	29.6 $\frac{1}{2}$		13	39	32	29.4	
14	46	23	29.4		14	39	33	29.5	
15	62 $\frac{1}{2}$	14	29.6		15	39	29	29.7	
16	41	19	29.5		16	35	30	29.8	
17	42 $\frac{1}{2}$	12	29.4		17	37	31	29.6 $\frac{1}{2}$	
18	50	10	28.9		18	36 $\frac{1}{2}$	36	29.4	
19	51 $\frac{1}{2}$	7	29.2		19	38 $\frac{1}{2}$	36	29.3 $\frac{1}{2}$	
20	45	8	29.2		20	36	32	29.3	
21	41	27	29.0		21	39	37	29.2	
22	50	8	29.4		22	46	35	29.4	
23	37	10	29.5		23	42 $\frac{1}{2}$	35	29.5	
24	33 $\frac{1}{2}$	6	29.4		24	52	35	29.2	
25	27 $\frac{1}{2}$	7	29.3		25	50	35	29.3 $\frac{1}{2}$	
26	30	11	29.4		26	56	36	29.7	
27	57	9	29.6		27	38	44	29.5	
28	38	4	29.6		28	43	46	29.7 $\frac{1}{2}$	
29	30	17	29.5		29	40	49	29.6	
30	30	20	29.4 $\frac{1}{2}$		30	52	42	29.9	
31	20	24	29.3						
1166 Grains.					1203 Grains.				

M A Y, 1693.					J U N E, 1693.				
D.	Grains.	Ther.	Barometer.	Weather.	D.	Grains.	Ther.	Barometer.	Weather.
1	56	36	30. 1	18 1	1	78	65	29. 9	75 1
2	61	26	30. 0	08 2	2	85	62	30. 0	11 2
3	66	21	30. 1	17 3	3	95	54	30. 2	22 3
4	61	19	30. 1	78 4	4	77	52	30. 1 $\frac{1}{2}$	25 4
5	52	31	30. 1	81 5	5	63	50	29. 9	78 5
6	48	45	29. 8	02 6	6	49	60	29. 7 $\frac{1}{2}$	03 6
7	59 $\frac{1}{2}$	35	29. 8	13 7	7	46	67	29. 7	76 7
8	51	34	29. 7	23 8	8	63	63	29. 7	08 8
9	51	31	29. 6	18 9	9	63	69	29. 8	14 9
10	43	35	29. 5	76 10	10	63	63	29. 8	08 10
11	49	30	29. 5	76 11	11	55	70	29. 8 $\frac{1}{2}$	22 11
12	54	32	29. 6	46 12	12	58	87	28. 8	54 12
13	59	26	29. 7	08 13	13	59	75	29. 9	24 13
14	59	32	29. 7 $\frac{1}{2}$	08 14	14	86	72	29. 7	04 14
15	46 $\frac{1}{2}$	35	29. 7	08 15	15	63	79	29. 8	10 15
16	46 $\frac{1}{2}$	34	29. 8 $\frac{1}{2}$	78 16	16	58	78	29. 9	14 16
17	56	36	30. 1	78 17	17	86	79	30. 0	14 17
18	70 $\frac{1}{2}$	35	30. 1	108 18	18	81	66	30. 0	07 18
19	58 $\frac{1}{2}$	47	30. 1	183 19	19	92	57	30. 1	17 19
20	76	50	30. 0	08 20	20	81	60	30. 0	74 20
21	62	52	30. 1	08 21	21	80	71	29. 9	14 21
22	73	64	30. 1	04 22	22	76	67	29. 88	07 22
23	78 $\frac{1}{2}$	64	30. 1	14 23	23	63	69	29. 7	78 23
24	90	62	29. 9 $\frac{1}{2}$	17 24	24	63	62	29. 6	18 24
25	61	74	29. 9	07 25	25	57	65	29. 8	17 25
26	67 $\frac{1}{2}$	68	29. 9 $\frac{1}{2}$	07 26	26	46	70	30. 0	08 26
27	64	75	29. 9 $\frac{1}{2}$	86 27	27	49 $\frac{1}{2}$	68	30. 00	77 27
28	71	67	30. 1	64 28	28	52	74	30. 0	88 28
29	80	89	30. 2	04 29	29	59	88	30. 2	08 29
30	89 $\frac{1}{2}$	70	30. 2	17 30	30	62	69	30. 2	08 30
31	106	68	29. 9						
1968 Grains.					2008 $\frac{1}{2}$ Grains				

JULY, 1693.					AUGUST, 1693.				
D.	Grains.	Ther.	Barometer.	Weather.	D.	Grains.	Ther.	Barometer.	Weather.
1	75	67	30. 0	0	1	80	71	29. 5	81
2	75	67	30. 0	77	2	77	73	29. 6	77
3	63	62	30. 0	12	3	77	63	29. 8	10
4	62	61	30. 1	72	4	78	64	29. 9	10
5	60	63	30. 1	92	5	79	73	29. 9	20
6	74	65	30. 0	16	6	81	70	29. 9	47
7	61	65	30. 0	92	7	94	83	29. 6	20
8	51	65	30. 0	72	8	79	86	29. 6	97
9	46	74	29. 9	92	9	68	82	29. 7	01
10	52	77	29. 9	72	10	70	83	29. 8	01
11	72	74	29. 8	42	11	92	85	29. 8	24
12	74	82	29. 4	82	12	70	86	30. 9	24
13	88	75	29. 7	92	13	81	75	29. 9	24
14	83	62	29. 9	94	14	68	75	29. 7	24
15	84	65	30. 1	44	15	69	74	29. 9	24
16	84	68	29. 8	44	16	77	72	29. 8	24
17	71	58	30. 1	76	17	77	77	29. 7	24
18	77	65	30. 2	48	18	84	77	29. 7	27
19	66	78	30. 1	48	19	86	64	29. 5	84
20	71	78	30. 1	76	20	78	68	30. 0	07
21	72	82	30. 0	76	21	68	67	29. 7	24
22	90	74	30. 0	42	22	71	65	29. 7	14
23	99	68	30. 0	82	23	75	55	29. 9	24
24	85	71	30. 0	92	24	64	54	29. 5	44
25	85	81	29. 9	14	25	63	57	29. 5	14
26	94	75	29. 9	48	26	58	59	29. 4	24
27	97	70	29. 8	92	27	60	55	29. 7	24
28	81	78	29. 7	52	28	53	52	29. 9	74
29	87	67	29. 9	92	29	53	58	29. 7	07
30	78	64	29. 9	76	30	53	56	29. 7	07
31	78	79	29. 3	82	31	63	48	29. 7	
2335 Grains.					2246 Grains.				

SEPTEMBER, 1693.					OCTOBER, 1693.				
D.	Grains.	Ther.	Barometer.	Weather.	D.	Grains.	Ther.	Barometer.	Weather.
1	53	53	29. 7	08 1	1	40	35	29. 9	75 1
2	55	50	29. 6	77 1	2	57	41	29. 6	75 1
3	61	50	29. 7	77 1	3	41	35	29. 7	75 1
4	61	48	29. 7	85 4	4	27	49	29. 6	75 1
5	63	44	29. 8	95 7	5	29	48	30. 0	75 1
6	74	40	29. 7	18 0	6	31	49	30. 2	75 1
7	62	39	29. 6	42 7	7	29	58	30. 0	75 1
8	59	49	29. 5	97 8	8	37	60	30. 0	75 1
9	40	52	29. 5	80 2	9	39	59	30. 2	75 1
10	50	48	29. 6	07 0	10	37	55	30. 1	75 1
11	46	41	29. 7	20 1	11	34	55	29. 9	75 1
12	48	43	29. 8	07 1	12	38	55	29. 8	75 1
13	46	53	29. 7	18 1	13	39	42	30. 0	75 1
14	43	57	29. 5	80 4	14	49	38	29. 8	75 1
15	46	70	29. 2	00 7	15	44	28	29. 7	75 1
16	49	54	29. 3	77 0	16	44	19	29. 7	75 1
17	46	52	29. 1	77 7	17	35	23	29. 1	75 1
18	52	45	29. 0	18 8	18	34	24	29. 2	75 1
19	48	45	29. 3	80 0	19	34	20	29. 2	75 1
20	50	44	29. 6	87 0	20	35	21	29. 5	75 1
21	43	42	29. 9	80 1	21	35	17	29. 9	75 1
22	41	51	29. 5	17 2	22	24	28	29. 7	75 1
23	46	45	29. 9	77 2	23	28	25	29. 7	75 1
24	44	52	29. 7	40 2	24	39	20	30. 0	75 1
25	41	47	29. 8	30 7	25	41	13	30. 0	75 1
26	43	47	29. 6	87 2	26	34	16	29. 9	75 1
27	46	45	29. 7	00 7	27	33	13	30. 0	75 1
28	47	40	29. 9	87 8	28	32	18	29. 8	75 1
29	50	44	29. 8	87 9	29	33	10	29. 8	75 1
30	40	42	29. 5	87 0	30	35	5	29. 7	75 1
					31	28	7	29. 4	75 1
1495 Grains.					1095 Grains.				

NOVEMBER, 1693.				DECEMBER, 1693.			
D.	Grains.	Ther.	Barometer. Weather.	D.	Grains.	Ther.	Barometer. Weather.
1	18	22	29. 6	1	34 $\frac{1}{2}$	—16	30. 0 Frost.
2	15	30	29. 7	2	16 $\frac{1}{2}$	—10	30. 0 Rain.
3	24	34	29. 6	3	12	— 0	29. 9
4	26	30	29. 7	4	12	7	29. 4 Some Rain.
5	33	21	29. 8	5	17 $\frac{1}{2}$	10	22. 2.
6	33	10	29. 8	6	33	15	29. 4 Some Rain.
7	29	9	29. 7	7	19 $\frac{1}{2}$	15	29. 1 $\frac{1}{2}$
8	20	23	29. 5	8	18	20	29. 0 Rain & much W.
9	21	21	29. 9	9	18	27	28. 6 $\frac{1}{2}$ R. and Storm.
10	21	30	29. 7	10	25	16	28. 9 Some Rain.
11	32	27	29. 7	11	28 $\frac{1}{4}$	13	29. 6
12	22 $\frac{1}{2}$	34	29. 5	12	28	9	29. 5
13	31	23	28. 4	13	25	14	29. 2
14	25 $\frac{1}{2}$	15	29. 9	14	15	20	29. 2 Some Rain.
15	27	10	29. 4	15	19	20	29. 5
16	25 $\frac{1}{2}$	3	29. 6	16	22 $\frac{1}{2}$	15	29. 5
17	26	— 7	29. 5	17	17 $\frac{1}{2}$	20	29. 5
18	21	— 1	29. 5 Great Fog.	18	21 $\frac{1}{2}$	10	30. 1
19	21	— 2	29. 5 Great Fog.	19	22	3	30. 0
20	19	2	29. 6	20	16	6	29. 8
21	15	5	29. 8 Fog.	21	14 $\frac{1}{2}$	9	29. 6
22	11 $\frac{1}{2}$	12	29. 7 Some Rain.	22	16 $\frac{1}{2}$	14	29. 3
23	20 $\frac{1}{2}$	14	29. 7	23	22	11	28. 5 Stormy.
24	24 $\frac{1}{2}$	8	29. 8	24	23	4	29. 0
25	24 $\frac{1}{2}$	5	29. 9	25	22	0	29. 5 Frost.
26	33	—12	29. 9 Frost.	26	22	5	29. 2 Rain.
27	33 $\frac{1}{2}$	—12 $\frac{1}{2}$	29. 9 Frost.	27	16	10	29. 3
28	27	—14	29. 8 Frost.	28	20	6	29. 0
29	42	—16	29. 8 } Water	29	25 $\frac{1}{2}$	0	29. 2 Frost.
30	42	—17	29. 9 } Frozen.	30	29 $\frac{1}{2}$	5	28. 6 Stormy.
764 Grains.				646 Grains.			

Note, That in the Column of the *Thermometer*, — denotes Degrees of Cold below the freezing Point, and that from the tenth of Nov. to the End belong to the foregoing Year 1692.

The Changes
of Weather
from the
Alterations
of the Gravi-
ty of the At-
mosphere;
by Dr. Gor-
den. n. 171.
p. 991.

XXXIII, 1. The *Air* agrees with all other *Fluids* in this, that it *gravitates*, and it has this peculiar Property (which is not so much observed of other *Fluids*) that its specific Gravity is not always the same. Now you know according to the certain Rules of the *balancing* of *Fluids* amongst themselves, every *Fluid* specifically lighter than another, will ascend and emerge above it, and every *Fluid* specifically heavier than another, will descend and subside below. Now there is some certain *Proportion* between the specific Gravities of the *Fluid* of *Air*, and of that which ascends in *Vapours*, and falls down again into *Rain*, and if this *Proportion* were still the same, 'tis like we would have no *Commixture* of those *Fluids*, but the *Vapours* would either always float above or always stay below. But this *Proportion* of their specific Gravity is frequently changed, for it's known that *Water* when warm and tepid is lighter than when it is cold, and the daily *Observations* of the different Heights of the *Mercury* in the *Baroscope* do make appear, that the *Atmosphere's* Gravity is not always the same. And now from these known Properties may be easily deduced a statical Account of the rising of *Vapours*, their being carried in the *Air* in Clouds, and their falling down again into *Rain*. For if we may be allowed to suppose that when the *Atmosphere* is heaviest, there is some such *Proportion* between its specific Gravity, and that of the *Fluid* of *Vapours*, as there is between *Water* and *Oyl*, the *Vapours* according to the known Laws of *Fluids* must needs ascend, and so long as this *Proportion* continues they must needs float above in the *Air*; but when the *Atmosphere's* Gravity is chang'd, the *Vapours* must fall down again.

I do not know any determinate Instrument that will indicate the *Ascent* of *Vapours*, as certainly as the *Baroscope* does the Change of the *Air's* Weight, (for our common *Hygrosopes* are not very exact, and besides I suppose their Change by Moisture shews rather the falling than the rising of *Vapours*) yet there are two or three *Observations* which seem certain *Indications* of their *Ascent*: as first, if the *Horizon* and the remote Hills seem smoaky, and inconspicuous, so that nothing can be seen at any Distance, and that tho' the Heavens be not cloudy but clear, and tho' there be no Fog, nor yet any Cap of Clouds upon the Hills (which do rather indicate the falling of *Vapours*.) Again, if when you look to any distant Part of the Country, round about you, it appear all in an undulating Motion, this seems to be a Sign of the plentiful rising of *Vapours*, for this is only occasioned by looking through an unequal waving Medium, which makes frequent Inflections of the Beams of Light, as you see any Object seems to have a tremulating Motion in all its Parts when you look upon it through Smoke. Another Indication of the *Ascent* of *Vapours* seems to be the copious rising of Steams above Waters, Marsh Grounds, and Fens, which is frequently seen in Frosts, and in cool Nights in Summer. To these I may add the Redness of the Sun (so as to be easily look'd upon) and Moon, a considerable Time before their setting, or after their rising. Now since I have had Occasion to make *Observations* of the *Baroscope*, I have always taken notice of all these, when the *Mercury* was rising, and consequently in the Increase of the *Atmosphere's* Gravity: But on the contrary, when the *Mercury* has been low in the *Baroscope*, and so the *Atmosphere's* Gravity less, I have observed none of these Effects, but the remote Hills were clear and distinct,

(unless

(unless sometimes a Cloud had fall'n down upon them) and no waving to be observed in the Air, nor Steams from the Waters. I know not whether I may add here a Conjecture about the great Light, and the *Capræ saltantes*, which are some Nights to be seen in the North. I have taken notice of them usually when the *Mercury* has been high in the *Baroscope*, and then they appearing in that Quarter of the Heavens where the Sun is at that Time below the *Horizon*; this has given me Occasion to think, that perhaps the Steams of Vapours may have ascended so far in the *Atmosphere* as to be beyond the Earth's Shadow in that Part of the *Horizon*, and so by refracting the Beams of Light toward us to occasion that Light, and those *Capræ saltantes*. It may be considered also whether the red Skies in the Evening, which betoken fair Weather, do not proceed from the Height of the Clouds occasioned at that Time by the Increase of the *specific Gravity* of the *Atmosphere*.

Now as to the falling down of the Vapours again, it is visible by their gathering into thick and dark Clouds, by the falling down of Clouds and Mists on the Tops of Hills, and thick Fogs in the Air, and by their dropping down into Rain, Snow, &c. and that these do usually fall out only when the *Mercury* subsides a little, and consequently when the *Atmosphere's Gravity* is less, is the constant Observation of those who have had Occasion to take notice of the Changes of the *Baroscope*.

Against this it may be objected, that it is observable many times that even when the *Mercury* in the *Baroscope* is rising, there will be Rain, and particularly sometimes in *North-East Winds*. To this I answer, That if the Clouds have been carried for some while towards one Quarter of the Heavens by the *Winds*, and then if the *Winds* do suddenly change into another Quarter, these *Vapours* which were formerly scatter'd into small Particles, and so did easily float, are suddenly driven together into little Drops, and so must needs fall down into *Rain*, and therefore the falling of *Rain* while the *Mercury* is rising, is observable only upon the sudden Change of contrary *Winds*.

But let us consider in the next Place, whether those frequent *Commutations* in the *Air*, which we call *Winds*, may not be accounted for upon the same Principles. That known *Definition* of *Archimedes* is universally acknowledg'd, *Quod earum partium minus pressæ expellantur a magis pressis*; so that if there be any Portion of a Fluid of a far less Pressure and Resistance than the rest, the whole Fluid runs in a *Current* thither, till all be reduced to an *Equilibrium*. Now it is evident that the Pressure of the *Air* is not always the same, and 'tis very probable (which *Experience* will determine, by making joint *Observations* of the *Baroscope* in several Places of the *Earth* at the same time) that the *Air's Gravity* is not alike chang'd throughout the whole *Atmosphere* in an Instant. So that when the *Air* becomes *specifically lighter* in one Place, or its Pressure lessened, the neighbouring Parts of the *Atmosphere*, whose *Weight* is not thus lessened, run thither in a *Current*, till the *Atmosphere* thereabouts be reduc'd to an *Equilibrium* again, and according to the Portion of *Air* thus changed, and the lessen'd or acquir'd Degrees of the *Weight* and *Spring*, the *Currents* or *Winds* are strong or weak, of a long or short Continuance. Now Observation and Experience do agree with this, the *Mercury* being found to
subside

subside for the most Part in the *Baroscope* at the rising of Winds; at least it is observed to be in Motion, and either rising or falling, and consequently, there is a Change in the *Atmosphere's* Pressure at that Time.

But the great Difficulty remains still, how to account for the different Changes of the *specifick Gravity* of the *Atmosphere*. Of this there can hardly be expected a satisfactory Account, till we come to know the Cause of Gravity in general, and of the Air's Weight in particular; and therefore I shall only here offer two or three Hints, which perhaps may incite others to consider it more narrowly. And *first*, it is now almost generally acknowledg'd, that there must needs be a *Fluid* much more subtile than common *Air*, and of a far greater Pressure than *Air*, which is the Cause of the Continuity and Cohesion of all terrestrial Bodies, and in which the *Air* seems as it were to float, and to have the same Relation to it, as the Vapours do in, and have to the *Air*, and therefore if we could reach its Nature and Properties, it might be considered what Influence this may have upon the Change of the Air's Gravity. Or, *secondly*, seeing the Infusion of one Liquor into another, in *Chymical Preparations*, will alter its *specific Gravity*, so that the Bodies which were formerly born up in it, will fall down and be precipitated, as the Particles of Gold floating thro' *Aqua Regis* will be precipitated by the Infusion of another Chymical Liquor, it may be considered, whether Plenty of nitrous Steams, or some such Mixture, may not alter the Air's *specific Gravity*. Or, *thirdly*, we may possibly come to a nearer Resolution of this, by considering the Influence which the Heat and Cold have upon the Air's Spring. The Air you know has this peculiar Property, which is not so much observed of other Fluids, that it is endued with *Elasticity* as well as Gravity, and therefore we are to consider what Influence the Change of its Spring may have upon the Change of its Weight; and it seems evident, that the Increase of its Spring doth diminish its Weight, and the lessening of its Spring will increase it; for upon the Increase of the Air's Spring, the Air is rarified, and so a lesser Portion of it presses upon the subjacent Fluid: But when it is lessened the Air is condensed, and so a greater Portion of it presses upon the subjacent Body. For Example, let us suppose the springy Particles of Air to be like the springy Hairs of Wool, or the Spring of a Watch; and that many Millions of Rows of them go to make up the Cylinder of Air, which from the top of the *Atmosphere* presses upon the *Mercury* in the *Baroscope*, and keeps it suspended to the Height of thirty *Inches*, let us suppose this Air rarified, so that all its springy Particles expand themselves, and therefore shut off of this Cylinder some thousands of those Rows; this Cylinder, being now made up of a far lesser Number of those Rows of Particles, must needs have a lesser Pressure upon the *Mercury*, so that it will subside, perhaps to twenty nine. And thus it continues till the Air's Spring be weakned, and so the Particles crowded again into narrower Room. Now if this be found to hold in the *Theory*, Experience seems very well to answer it: For I have hitherto observed, that in cold Weather, and sharp Frosts, the *Mercury* rises highest in the *Baroscope*, and if the Foreign Measures agree with ours, it is usually higher here than in *France* or *Italy*.

I shall here after all subjoin two or three Observations, which may serve to confirm what has been said. The first is of the course of the Weather under or near the *Line*. I have read in the 2d and fourth Parts of *Purchas his Pilgrims*, (and I doubt not but later Travellers attest the same Truth) That, in *Brasil*, and *Guiana* in *America*; in *Guinea*, *Congo*, and *Ethiopia* in *Africa*, in the *East-Indies*, and the *Maldiv*e Islands; they have almost continual Floods of Rain from about the beginning of *May* to the end of *August*, which they call their Winter, and the rest of the Months of the Year fair and clear Weather, which they call their Summer: So that when the Sun is nearest to them, they have constant Rains, and when remotest fair Weather. And this I impute, amongst other causes, to the extraordinary rarefaction of the Air, and lessening of its *specific* Gravity there at that Time, so that the Vapours in the neighbouring parts of the Air, do all flow thither, and descend as it were in Floods of Rain. And as this is reckoned to be the Cause of the Inundation of the *Nile*, and some other Rivers, so perhaps this may be the Reason also, why those Countries which are neighbouring to them, and somewhat remoter from the *Line*, such as *Egypt*, and the like, have seldom or never any Rain.

My second Observation is of the *Baroscope*, viz. That when the Wind is North, North-east, or North-west, the *Mercury* ever rises, and so the Air is heavier; but when the Wind comes from the South, South-east, or South-west, it falls, and so the Air's Gravity is less: by which we may see what Influence the Cold and Heat have upon the Air's Weight; and you know a cold Wind is said to drive the Sails of a Ship much more forcibly than a warm.

My third Observation is of an Experiment of the honourable Mr. *Boyle*; n. 6. p. 2047. I made, *saith he*, by Distillation a Blood-red Liquor, which chiefly consisted of such saline spirituous Particles as may be obtained from the Mass of Blood in human Bodies. This Liquor is of such a Nature, that if a Glass Viol about half filled with it, be kept well stoppt, the red Liquor will rest as quietly as any ordinary one, without sending up any Smoak; but if the Viol be unstoppt, so that the external Air be permitted to come in, within a quarter of a Minute or less, there will be elevated a copious white Smoak, which will not only fill the upper Part of the Glass, but plentifully pass out into the open Air, till the Viol be again stoppt. *And a little after he adds*, n. 171. p. 1000. If the unstoppt Viol were placed in our *Vacuum*, it would not emit any visible Steams at all, nor so much as appear in the upper Part of the Glass that held the Liquor; whereas when the Air was by degrees restor'd at the Stop-cock, the returning Air would presently raise the Fumes, first into the vacant Part of the Viol, whence they would ascend into the Capacity of the Receiver; and likewise when the Air that was requisite to support them was pumped out, they also accompanied it, as their unpleasant Smell evinced, and the red Spirit, tho' it remained unstoppt, emitted no more Fumes till the new Air was let in again. *So far He*. Such you see was the Proportion between the Gravity of the Vapours of this red Liquor and the Air, that the Air being in its ordinary Degree of Gravity, these Vapours did ascend: but the Air's Gravity being much lessened in the Receiver, by the pumping out a great deal of it, and so expanding the Spring of the rest, it was not able to elevate those Vapours.

By Dr. Wallis, ib. p. 1002.

2. That there is in our Air a Body more subtile than are the Fumes and Vapours mingled with it in our lower Region, and which with it do make up that heterogeneous Mixture which we commonly call Air, I think to be very certain: But whether that subtile Body, be (as Dr. Garden seems to suppose) much heavier, than our common Air, I much doubt; and do rather think it not, not having hitherto observed any cogent Experiment, either to prove it heavy or elastick: But it may, for ought I know, be void as well of Weight as Spring; and, what we find of either, in our common Air, may be attributed to the other Mixtures with it. For the Air being of a different Gravity, in different times and Places (arising I suppose from the different kinds and quantities of the Fumes and Vapours and other Particles which are Ingredients in it, and the different Force of the Sun's Heat acting thereupon, increasing or allaying the Spring thereof, and otherwise) we are therefore to consider of the Air as a Fluid, whose Parts are in some Places heavier, and others lighter. And therefore much of a like Nature as if they were different Fluids, of different *specifick* or intensive Gravity, one from the other.

Now when several Fluids, or several parts of a Fluid, are thus of different Weights, they will (from the general Nature of heavy Fluids,) when undisturbed, change Places with one another, till the heavier becomes lowest, and the lighter highest.

And this not only as to the minuter Parts; it is observed in Chymical Precipitations, or the sinking of Sand in Water, or its smaller earthly Particles which subside in a muddy Sediment, and the like of other Liquors when at rest, and the Atoms (as they were wont to be called) flying in the Air when disturbed, but subsiding in the form of Dust when at rest, all which, according as they be smaller, do (*ceteris paribus*) subside more slowly: But much more as to larger Parcels; as when Oyl, Wine, Water, Beer, or other the like Liquors, are put together in the same Vessel, as will be observable to the Eye, especially when their Colours are considerably different.

And the same will happen, if some Parts of the same Liquor, do accidentally acquire, by Expansion, or otherwise, a greater Degree of Lightness than the other Parts, those lightned Parts ascending, the heavier subside; as when Water, Beer, or other thin Fluids, be gradually heated by a Fire underneath, the lower Parts being first warmed, ascend to the Top, while the colder and heavier subside; whence we find in such Cases that Bubbles do arise, and that at the Top is warmer than that at the Bottom: But in case what is warmed be of a thicker Consistence, so as that the Parts cannot readily shift Places, that at the bottom will be hotter; and in case it be heated by Fire over it, there will (I suppose) be no such Bubbling, (or not so much of it,) that at the Top being first heated.

From such Considerations as this, Dr. Garden doth well observe, that some Parts of the Air being thus, by Rarefaction, or increasing the Spring thereof, or otherwise, become lighter than others; these heavier Parts, rushing into the Places of those lighter, may cause a Wind as from such Parts; (in like manner as, on a like Occasion, a Tyde or Current would arise in Water;) and other Accidents of a like Nature. And contrariwise, on a contrary Occasion.

And this I take to be true, (though such Accidents happening very variously and uncertainly, will cause such confusion of motions, and disturbance of each other, that it will be hard to reduce them to a regular Adjustment.)

But I add thereunto, that the earth's diurnal motion compounded with its annual, (if we admit that *Hypothesis*, as most do now a-days) the one in some parts accelerating, in others retarding the other: and its Difference in different times of the Year, by Reason of the Obliquity of the *Zodiack* to the *Equinoctial*) and in different times of the month (because of the Moon's different Position, which is an Appendage to the Earth's motion, and doth thereby differently affect it,) and according to the different Place of the Earth and Moon, as to the *Aphelion* or *Perihelion* of the one, and the *Apogaeum* or *Perigaeum* of the other, seem to me to be of much greater Consideration, not only as to the *Ebbing* and *Flowing* of the Sea, but as to the Winds also: especially the *Breezes* and *Trade-winds*, which at certain Times of the Day, of the Year, of the Month, are observed to blow constantly, or most frequently, from such or such a Coast.

And I am not sure, that the Body of Earth and Water (or terraqueous Globe) is exactly spherical, allowing only for the small inequalities of Hills and Dales, which in a Body of that Greatness are inconsiderable, but may have somewhat of an *Oblong Spheroid*, having a longer Axis from *Pole* to *Pole*, than at the *Equator*. And tho' this cannot be much, because of the Earth's Shadow in the Moon's Eclipse appearing circular; and the Descent of heavy bodies being always (as to Sense) in a perpendicular to the *Horizon*; yet if it be but little, this, with the Compound Motions before mentioned, will give the Air a considerable Disturbance.

To which I may add also, that we are not sure that the Seas and Continents, which are of very different comparative Weights, Earth being heavier than Water, are so adequately adjusted the one to the other, as that its Center of Gravity, by which a Plain passing divides it into parts *Æquipoponderant*, is the same with its Center of Magnitude, by which it is divided into Parts equally great, which, if it happen to be otherwise, will with the rest make the Confusions of the Air's Motions yet greater.

From the comparative Weight or Lightness of the Air at different times, he deduceth also the rising or falling of Vapours in it. As if when such Fumes or Vapours, or other the like Matters are lighter than the Air, they ought, according to the exact Rules of *Hydrostaticks*, to ascend therein; but when heavier than so, to fall down. And this certainly (*cæteris paribus*) is to be admitted also. Only I add thereto, that these *statick Principles* do chiefly take place, when things are otherwise at Rest and Quiet: But when they are in Commotion, it is many times much otherwise. And in such Cases, we must, besides the respective Gravity take into Consideration the Force, Impulse, or Impetus, that is superadded to the respective Gravity of the Parts of Matter. Thus, if a Bottle be shaken, the Sediment at the Bottom, tho' heavier, and for which Cause it did before subside, will be mingled with the supernatant, (finer and lighter) Liquor. And if a Room be swept, it will, as we use to speak, make a Dust, that is, the small earthy particles

Particles of Dust will rise and mingle with the Air, not because they be lighter than it, for we see that at leisure they will subside again; but because by a Force upon them they be put into Motion. And this I take to be the cause of Fumes, Vapours, and other like Matters, (most of them) which ascend in the Air, not because lighter than it, but because impell'd upward out of the Bowels of the Earth, or from the superficial Parts of it, either by some subterranean Heats, or other Ferments, that put them into Motion, and force them upward, where they remain suspended in the Air, so long as that Force continues, or the Force of others sent after them on the like Errand, which rather impels them farther, than gives them leave to fall, till either such Force abate, or the great Weight of so many things suspended doth overpower, not only the Air's Weight, but the Strength of that that impelled them. And that there are such Fumes, and other like matter projected upwards from the Bowels of the Earth, and some of them with great Violence, is undeniable, not only from Earthquakes and other Eruptions, with great Noises, as well of Vapours as of burning Mountains, but even poysonous Steams, and others, in Mines and bubbling Springs, where Bubbles of Air are seen to make their Passage through the Water, and other Perspirations of Air or Vapour, through Cranies, or small Passages of the Earth, discoverable by Steams, whereof some will take Fire at the Light of a Candle, or by the moving of Leaves, and other light Things laid on the Mouths of such private Passages, and by many other Means. And to such Causes I do principally attribute the *Origin of Winds*, and the ascent of most other Things, which from this lower World mount into the Air: and without this, the comparative Gravity of the Air and them, would give us but a lame Account of them.

There is yet another Notion suggested, which is also very considerable as to this Affair, which is the weakning or strengthning the Spring of the Air. That Water hath, of it self, nothing of Spring or Elasticity, otherwise than by reason of some airy Parts, or other elastick Bodies, which may be included within it, is generally held, at least none considerable, such as by any Experiments hitherto made, can be clearly evinced so to be. But that the Air, (such Air at least as is the common Air which we are conversant with) is elastick, is I think out of doubt: the Experiments which prove its Spring being so many and evident, beyond Exception. And that this Spring of the Air is sometimes stronger, and sometimes weaker, I think, is undoubted also; and that the Spring of the Air is strengthned both by Compression and by Heat, but in a different Manner. If the same Quantity of Air be compressed into a lesser Room, the Spring is certainly stronger, as is undoubtedly seen in the Wind-Gun, and other compressive Engines. And the same Quantity of included Air in a close Vessel, so as not to communicate with the external Air, will by Application of Heat to it have its Spring strengthned, and drive its Counterpoise farther off, or if need be, compress it, as is to be seen in *Thermoscopes* of all sorts.

If the Spring be strengthned by Compression, it is manifest that the intensive Gravity must be thereby increased, because the same quantity of Air, and consequently of Weight, extensively taken, is now contracted into a lesser Room,

Room, which therefore must be intensively heavier, (as being the same Weight in a lesser Bulk.) Now this may possibly, as a great Pressure, or stronger Spring, force up the Vapours under it with a greater *Impetus* (according to the Notion I mentioned before) and so make them fly higher: (unless we should suppose it may be relieved, by shortning the height of the *Atmosphere*;) but not so as to make them lighter; but rather the contrary, as pressing them closer: Much less to make them (as the Phrase is,) *Specifically Lighter* than is the Air it self (though thus compressed,) and it leaves less Room to receive them between the Particles of the compressed Air, as being now thrust closer together.

If the Spring be strengthened the other way; so as by Heat it useth to be: This doth rather diminish its intensive Gravity, by thrusting its Parts further asunder, and so possessing a larger Room. Now in case this Air be, by a close Vessel, confined so as not to expand upward; it will certainly press the harder on the stagnant Quick-silver under, and make that in the Tube rise higher. But in case it be unconfined, as in the open Air; it may as well relieve it self upward, by making the *Atmosphere* in this Part so much the higher.

Nor is there any Necessity, as to the subjacent Parts, that the *Atmosphere* shall be every where of the same Height. But the Laws of *Statics*, as to the subjacent Parts, be equally preserved without it, the greater Altitude compensating for the Levity of the Parts, as when a Portion of the Sea is covered with a Fleet of Ships, the under Parts are equally pressed, partly by Water, and partly by Ships; though the Tops of the Ships over some Parts be higher than the Surface of the Water over others. Only, in such Case, the upper Part of the *Atmosphere*, being fluid, may flow collaterally over the other Parts on either side if lower. And so, at leisure, (if thus remaining otherwise undisturbed) reduce it self to an equal Height in all Parts. Like as the Sea would do, in a perfect Calm, though otherwise its Waves and Billows are far from being in all Places perfectly plain and even.

But, however, though the Spring fortified by Heat, may thus relieve it self upwards, (yet because it presseth every way,) it must endeavour the like downward also, and thereby press harder what is under it; and because it will require Time to work upward gradually before the Effect reach the Top of the *Atmosphere*; and because by such Dilatation of its Parts, more Room is left in the Intervals to receive what is forced: 'Tis reasonable to believe that in such Cases, the pressed Vapours (*ceteris paribus*) may rise more copiously, than when the Spring of the Air, (for want of Heat) is less strong. The rather because the same Heat which thus fortifies the Spring of the Air, doth also rarify the Vapours and make them lighter: and may also fortify the subterranean Heat (or whatever else it is,) that drives them up. Notwithstanding all which, we have more Rains in Winter; which should argue, that more Vapours do then arise to supply them.

But I suspect that in this whole Business (of strengthening the Spring) there may be a Fallacy put upon us: And what we think to be done upon the
open.

open Air, is indeed done upon the Quick-silver; or rather upon the Air latent therein. My meaning is this; we find that in very hot Weather, and also in frosty Weather, the Quick-silver in the Tube commonly stands very high; from whence we are apt to conclude, that therefore the outward Air presses very hard on the stagnant Quick-silver, without the Tube: Wherein I am not satisfy'd; for we are to consider, that, in filling the Tube with Quick-silver, before it be inverted, if great Care be not used to cleanse it from Air, many Airy Particles will remain mixed with it; which, while their Spring is weak, are easily pressed by the Weight of the Quick-silver so close as hardly to be discerned otherwise than by the Effect: But when, by the external Heat, their Spring is strengthened, they expand themselves, and cause the Quick-silver, wherein they are, to swell in Bulk, without increasing its Weight; and consequently to stand higher though not to press heavier.

And the same Account, perhaps, may serve for its standing so high in frosty Weather. Water, we know, though it contract with Cold, yet when it comes to freeze, doth expand it self. (Which makes Ice lighter than Water, and to swim on the Top of it.) Now whether this be purely of it self, (or in part at least) from the Particles of Air lodged in it, may not perhaps be so easy to determine. However, if there be the like Effects on Air, as on Water, (namely that it expands with Freezing,) or if in the Quick-silver there be lodged Particles of Water as well as of Air; we have, either way, an account of this *Phenomenon*. For then the small Particles, whether of Air, or of Water, lodged in the Quick-silver being thus expanded by Freezing, will make the Quick-silver swell, and so stand higher, without increasing its Weight; and consequently, without arguing a greater Weight of external Air pressing on the stagnant Quick-silver.

The Circulation of Watry Vapours; by Mr. Edm. Halley, n. 1192. p. 468.

XXXIV. I have formerly attempted to explain the manner of the rising of Vapours by Warmth, by shewing that if an Atom of Water were expanded into a Shell or Bubble so as to be ten times as big in Diameter as when it was Water, such an Atom would become *Specifically Lighter* than Air, and Rise so long as that *Flatus*, or warm Spirit, that first separated it from the Mass of Water, shall continue to distend it to the same degree; and that Warmth declining, and the Air growing cooler and withal *Specifically Lighter*, the Vapours consequently shall stop at a certain Region of the Air, or else descend, which may happen upon several Accounts, as I shall by and by endeavour to make out. Yet I undertake not, that this is the only Principle of the Rise of Vapours, and that there may not be a certain sort of matter whose *Comatus* may be contrary to that of Gravity; as is evident in Vegetation; wherein the tendency of the Sprouts is directly upwards, or against the Perpendicular. But whatever is the true cause, it is in fact certain, that Warmth does separate the Particles of Water, and emit them with a greater and greater Velocity, as the Heat is more and more intense, as is evident in the Steam of a boiling Cauldron, wherein likewise the Velocity of the Ascent of the Vapours does visibly decrease till they disappear, being dispersed into and assimilated with the ambient Air.

Vapours

Vapours being thus raised by Warmth, let us for a first Supposition put, that the whole Surface of this Globe were all Water very deep, or rather that the whole Body of the Earth were Water, and that the Sun had his Diurnal course about it: I take it, that it would follow that the Air of it self would imbibe a certain quantity of Aqueous Vapours, and retain them like Salts dissolved in Water; that the Sun warming the Air, and raising a more plentiful Vapour from the Water in the Day time, the Air would sustain a greater proportion of Vapour, as warm Water will hold more dissolved Salts, which upon the absence of the Sun in the Nights would be all again discharged in Dews, analogous to the Precipitation of Salts on the cooling of the Liquors; nor is it to be believed that in such case there would be any diversity of Weather, other than periodically, every Year alike, the mixture of all Terrestrial, Saline, Heterogeneous Vapours being taken away; which as they are variously compounded, and brought by the Winds, seem to be the Causes of those various Seasons which we now find. In this case the Airy Regions, every where at the same height, would be equally replenished with the proportion of Water it could contain, regard being only to be had to the different degree of warmth, from the nearness or distance of the Sun; and an Eternal East-wind would blow all round the Globe, inclining only to the same side of the East, as the Latitude does from the *Æquator*; as is observed in the *Ocean* between the *Tropicks*.

Next let us suppose this Ocean interspersed with wide and spacious Tracts of Land, with high Ridges of Mountains; such as the *Pyrenean*, the *Alps*, the *Apennine*, the *Carpathian* in *Europe*; *Taurus*, *Caucasus*, *Imaus*, and several others in *Asia*; *Atlas* and the *Montes Luna*, with other unknown Ridges in *Africa*, whence come the *Nile*, the *Nigre*, and the *Zaire*; and in *America* the *Andes*, and the *Apalatean* Mountains: Each of which far surpass the usual height to which the Aqueous Vapours of themselves ascend, and on the Tops of which the Air is so Cold, and rarified, as to retain but a small part of those Vapours that shall be brought thither by the Winds. Those Vapours therefore that are raised copiously in the Sea, and by the Winds are carried over the low Land to those Ridges of the Mountains, are there compelled by the Stream of the Air to mount up with it to the Tops of the Mountains, where the Water presently *Precipitates*, gleeting down by the Crannies of the Stone; and part of the Vapours entering into the Caverns of the Hills, the Water thereof gathers as in an *Alembick* into the Basons of Stone it finds, which being once filled all the overplus of Water that comes thither runs over by the lowest Place, and breaking out by the sides of the Hills, forms single Springs; Many of these running down by the Valleys, or Guts between the Ridges of the Hills, and coming to unite, form little *Rivulets* or *Brooks*; many of these again meeting in one common Valley, and gaining the plain Ground, being grown less rapid, become a *River*; and many of these being united into one common Chanel, make such *Streams* as the *Rhine*, the *Rhone*, the *Danube*; which latter one would hardly think the Collection of Water condensed out of Vapour, unless we consider how vast a Tract of Ground that

River

River drains, and that it is the Sum of all those *Springs* which break out on the South side of the *Carpathian* Mountains, and on the North side of the immense Ridge of the *Alps*, which is one continued Chain of Mountains from *Switzerland* to the *Black Sea*. And it may almost pass for a Rule, that the *Magnitude* of a *River*, or the Quantity of Water it evacuates, is proportionable to the Length and Height of the Ridges from whence its *Fountains* arise. Now this *Theory* of Springs is not a bare *Hypothesis*, but founded on Experience, which it was my Luck to gain in my abode at *St. Helena*; where in the Night time on the Tops of the Hills about 800 Yards, above the Sea, there was so strange a Condensation, or rather Precipitation of the Vapours, that it was a great Impediment to my Celestial Observation; for in the clear Sky the Dew would fall so fast as to cover, each half quarter of an Hour, my Glasses with little Drops, so that I was necessitated to wipe them off so often, and my Paper, on which I wrote my Observations, would immediately be so wet with the Dew that it would not bear Ink: By which it may be supposed how fast the Water gathers in those mighty high Ridges I but now named.

Thus is one Part of the Vapours blown upon the Land returned by the Rivers into the Sea, from whence they came. Another Part by the Cool of the Night falls in Dews, or else in Rains, again into the Sea before it reaches the Land; which is by much the greatest Part of the whole Vapour, because of the great Extent of the Ocean, which the Motion of the Winds does not traverse in a very long space of Time: And this is the Reason why the Rivers do not return so much into the *Mediterranean* as is extracted in Vapour. A third Part falls on the lower Lands, and is the *Pabulum* of *Plants*, where yet it does not rest, but is again exhaled in Vapour by the Action of the Sun, and is either carried by the Winds to the Sea, to fall in Rain or Dew there; or else to the Mountains to be there turned into Springs: And though this does not immediately come to pass, yet after several vicissitudes of rising in Vapour and falling in Rain or Dews, each Particle of the Water is at length returned to the Sea, from whence it came. Add to this, that the Rain-water, after the Earth is fully sated with Moisture, does, by the Valleys or lower Parts of the Earth, find its way into the Rivers, and so is compendiously sent back to the Sea. After this manner is the *Circulation* performed: and I doubt not but this *Hypothesis* is more reasonable, than that of those who derive all Springs from the Rain-waters, which yet are perpetual and without diminution, even when no Rain falls for a long space of time: Or than that that derives them from a Filtration, or *Percolation* of the Sea-waters through certain imaginary Tubes or Passages within the Earth, wherein they lose their Saltness. This besides many others labouring under this principal Absurdity, that the greatest Rivers have their most copious Fountains farthest from the Sea, and whether so great Quantities of fresh Water cannot reasonably be derived any other way than in Vapour. This, if we may allow *Final Causes*, seems to be the design of the Hills, that their Ridges being placed through the midst of the *Continents*, might serve as it were for *Alembicks*, to distil Fresh Water for the Use of Man and Beast, and their Heights

Heights to give a Descent of those Streams to run gently, like so many Veins of the *Macrocosm*, to be the more beneficial to the Creation. If the Difference between Rain and Dew, and the Cause why sometimes 'tis Cloudy, at other times Serene, be enquired, I can offer nothing like a proper Solution thereof, only with Submission to propose Conjectures, which are the best I can find, *viz.* That the Air being heap'd up with the meeting of two contrary Winds, when the Mercury is high, the Vapours are the better sustained and kept from coagulating or condensing into Drops, whereby Clouds are not so easily generated: And in the Night the Vapours fall down single as they arose in *imperceptible* Atoms of Water. Whereas when the Mercury is low, and the Air rarefied by the Exhaustion thereof, by two contrary Winds blowing from the Place, the Atoms of Air keep the Vapours not so well separated, and they coalesce into visible Drops in the Clouds; and from thence are easily drawn into greater Drops of Rain. To which 'tis possible, and not improbable, that some sort of saline or angular Particles of terrestrial Vapour being immixt with the Aqueous, which I take to be Bubbles, may cut or break their Skins or Coats, and so contribute to their more speedy Condensation into *Rain*.

XXXV. The *Trade* or *Tropick Winds* seem in great Part to arise from the daily and constant Breath of the *Sargossa*, or *Lenticula Marina*, which grows in vast Quantities from 36 to 18 Degrees Northern Latitude, and elsewhere upon the deepest Seas; because the Matter of that Wind, coming (as we suppose) from the Breath of only one Plant, it must needs make it constant and uniform; whereas the great Variety of Plants and Trees at Land must needs furnish a confused Matter of Winds. Again, the *Levant Breezes* are briskest about Noon, the Sun quickning the Plant most then, causing it to breath faster and more vigorously; and that Plants mostly languish in the Night is evident from many of them, which contract themselves and close at that time; also from the Effects of our Winters upon them, which cause them to cast both Fruit and Leaves too; whereas they are said (the same Plants for kind) universally to flourish all the Year alike within the *Tropicks*.

The Cause of Trade-Winds; by Dr. M. Lister, n. 156. p. 494.

As for the Direction of this *Breeze* from East to West, it may be owing to the general *Current* of the Sea; for a gentle Air will still be led with the Stream of our Rivers, for Example. Again every Plant is in some measure an *Heliotrope*, and bends it self and moves after the Sun, and consequently emits its Vapours thitherward; and so its Direction is in that respect also owing in some measure to the Course of the Sun.

XXXVI. 1. It is generally known that there are continual Eastern Winds under the *Line*, which they call *Breezes*, and therefore the Accounts of *Spanish* Voyages bear, that in their going to the *West-Indies* they sail southwards from *Spain*, along the Coast of *Africk*, till they be beyond the *Tropick* of *Cancer*, within 20 *Deg.* of the *Line*, where they presently find an Easterly Wind, and so they sail on Westwards with full Wind, so as they have scarce any need to touch their Sails in the whole Voyage: And this they give as the Reason why the Voyage from *Spain* to the *West-Indies* is shorter, more easy, and more assured, than the return to *Spain*. In the

The Cause of Winds; and of the Change of Weather; by Dr. Geo. Gordon, n. 17. p. 1148.

South Sea also going from *New Spain* or *Peru* to the *Philippines* or *China*, their Voyage is easy, sailing always from East to West near the *Line*, where the Easterly Winds blow in their Poop. *Acosta* reports that in the Year 1584, there went a Ship from *Calloa* in *Lima* to the *Philippines*, which sailed 2700 Leagues without sight of Land, and this in two Months, their Course being almost under the *Line*.

Now these continual Easterly Winds between the *Tropicks*, I suppose to proceed both from the Motion of the Earth, and the vertical Influences of the Sun, after this manner. As you know the vast Fluid and *Æther*, in which the Earth floats in its annual Motion, moves forward with the Earth in that Motion, or rather carries the Globe of the Earth along with it; even so the *Atmosphere*, and a large Vortex of *Æther* beyond the Moon, goes round with the Earth in its Diurnal Motion, which tho' according as it is removed from the Earth it may be proportionably slower in its Motion, yet that Portion of the *Atmosphere*, which is nearest the Earth and surrounds it, may be supposed to keep equal Pace with the Earth in its Motion; and if there were no changes in the *Atmosphere's* Gravity, I suppose it would always go along with the Globe of the Earth from West to East in an uniform Motion, which would be wholly insensible to us. But that Portion of the *Atmosphere* under the *Line*, being extremely rarefied, its Spring expanded, and so its Gravity and Pressure much less than the neighbouring Parts of the *Atmosphere*, and consequently uncapable of the uniform Motion to the East, it must needs be prest West-wards, and make that continual Breeze from East to West between the *Tropicks*.

2. The same accounts bear, that on this side the *Tropick*, about 28 or 30 deg. there are to be found constant Westerly Winds, and therefore the *Spanish* Fleets from the *West-Indies* do not return the way they went, but those both from *Peru*, and *New Spain*, Sail along the Coast Northward till they touch at *Havana* in *Cuba*, and being joyn'd together there, they seek their height without the *Tropicks*, where presently they find Westerly Winds which serve them till they come in view of the *Azores*, and from thence to *Sevil*. In like manner in the *South-Sea*, those which return from the *Philippines*, or *China*, to *Mexico*, to the end they may recover the Western Winds, mount a great height till they come right against the Island of *Japan*, and discovering *California* they return by the Coast of *New Spain* to the Port of *Acapulco*, from whence they parted. So that though they Sail easily from East to West, in both Seas, within the *Tropicks*, for that the Eastern Winds reign there; yet returning from West to East they must seek the Western Winds without the *Tropicks* in the height of 27 Degrees.

Now the Reason of this seems to me clearly deducible from the former; for the Pressure of Air between the *Tropicks* being continually less than the neighbouring Parts of the *Atmosphere*, and so consequently by them pressed West-ward, way being thereby given to the neighbouring Air for some Deg. without the *Tropicks*, its Motion from West to East is proportionably increas'd beyond that uniform Motion it would have if the whole

Atmosphere

Atmosphere were of an equal Pressure, and consequently there will blow a constant Wind from West to East for some *Degrees* beyond the *Tropicks*.

3. Those Easterly Winds between the *Tropicks*, by what I can collect from the accounts of Eastern Voyages, do not blow constantly from the same Point, nor directly from the East; but for the one half of the Year, viz. from *April* to *November* or thereabouts, they come from the South East, and for the other half of the Year, viz. from *November* to *April*, they blow from the North East. And these I suppose they call their *Monsoons*, and *Trade-Winds*. Hence it is that they who Sail from *China*, *Japan*, &c. to *Bantam*, must wait the Northerly *Monsoon*, which falls between *November* and *April*; and they who return from *Bantam*, must go back again when the Southerly *Monsoon* comes, which is between *April* and *November*; and the *Currents* of the *Sea* are said to observe the same Motion, and Changes, with the Winds. I know not whether these *Monsoons* do blow exactly from the same Points, in all Parts, for it's like where there are Bays, Highlands, and Islands, &c. the *Monsoons* may blow from different Points; but this is chiefly to be understood of open Seas.

Now these *Monsoons* I think may be easily accounted for from what has already been said, anent the Cause of the continual Easterly Winds between the *Tropicks*, for seeing the lessening of the Air's Pressure under the *Line*, and the Pressure of the Neighbouring Parts of the *Atmosphere* thereupon, occasion these continual Breezes, if the Sun were constantly in the *Æquinoctial Line*, it is like the Wind would blow still directly from the East, but in that he is the one half of the Year on the one side of the *Line*, and the other half on the other, there must of necessity follow a Change of these Breezes into stated *Monsoons*. For imagine the *Atmosphere* to be divided into two equal Hemispheres by the *Æquinoctial Plane*, if the Sun were always in the Plane, there would be still an equal Pressure from both these Hemispheres upon the Air under the *Line*, and the Breeze should be directly from the East. But now when the Sun comes on the North side of the *Line*, as far as the *Tropick of Cancer*, and back again, there is not an equal Balance, but the Pressure of the Southern Hemisphere of the Air must needs be greatest, and consequently the Breeze must blow all that Season from the South East, and when the Sun returns again to the Southward of the *Line*, as far as *Capricorn*, and back again, the Pressure of the Northern Hemisphere must needs preponderate, and make the Wind blow all that Half Year from the North East. And this seems to accord very well with Experience, for their Northern *Monsoons* are in our Winter Season, when the Sun is in the Southern Signs, and their Southern ones in our Summer when he is in the Northern Signs.

4. The Rivers of *Indus* and *Ganges*, where they enter the Ocean, do contain between them a large *Chersonesus*, which is divided in the middle by a Ridge of high Hills, which they call the *Gate*, which run along from East to West and quite thorough to Cape *Comori*. On the one side is *Malabar*, and on the other *Coromandel*. On the *Malabar* side between that Ridge of Mountains and the Sea, it is after their appellation Summer from *September* till *April*; in which time it is always a clear Sky, without once,

or very little, Raining. On the other side the Hills, on the Coast of *Coromandel*, it is at the same time their Winter, every Day and Night yielding abundance of Rain. And from *April* to *September* it is, on the *Malabar* side, their Winter, and on the other side their Summer: So that in little more than 20 Leagues Journey in some Places, as where they cross the Hills to *St. Thomas*, on the one side of the Hill you ascend with a fair Summer; on the other you descend with a stormy Winter. The like is said to be at *Cape Razalgate* in *Arabia*. And *Dr. Trapham* relates the same of *Jamaica*, intimating that there is a Ridge of Hills which runs from East to West thro' the midst of the Island, and that the Plantations on the South-side of these Hills have from *November* to *April* a continual Summer, whilst those on the North-side have as constant a Winter, and *à contra* from *April* to *November*.

From these and such like Accounts it seems evident, that a bare lessening of the *Atmosphere's* Gravity will not occasion Rain, but that there is also needful either a sudden Change of Winds, or a Ridge of Hills to meet the Current of the Air and Vapours, whereby the Particles of the Vapours are driven together, and so fall down into Drops of Rain. And hence it is, that whilst the Wind blows from the North-east, *viz.* from *November* to *April*, there are continual Rains in the northerly Plantations of *Jamaica*, and on the side of *Coromandel* in the *East-Indies*, because the Winds beat against that side of the Hills; and so there is fair Weather on the other side of these Hills, in *Malabar* and the southerly Plantations of *Jamaica*, there being no Winds to drive the Vapours together. But in the southerly *Monsoon*, *viz.* from *April* to *November*, *Malabar* and the southerly Plantations of *Jamaica*, have Floods of Rains, the Wind beating against that side of the Hills, whilst in *Coromandel* and the other side of *Jamaica*, there is Fair and Clear Weather. The Maps make those Mountrins of *Gate* run south and north, and if so the *Monsoons* must blow from other Points by reason of the neighbouring Countries and Islands, or else this is not the true Cause of these Seasons.

This serves also to clear the Singularity of Seasons in *Peru*, beyond any other Parts of the Earth, and seems to be assigned by *Acosta*, as the Cause of it. *Peru* runs along from the Line Southwards about 1000 Leagues. It is said to be divided into three Parts, long and narrow, which they call *Lanos*, *Sierras* and *Andes*; the *Lanos*, or Plains, run along the *South-Sea* Coast; the *Sierras* are all Hills with some Vallies; and the *Andes* steep and craggy Mountains. The *Lanos* have some ten Leagues in breadth, in some Parts less and in some more; the *Sierras* contains some 20 Leagues in breadth, the *Andes* as much, sometimes more sometimes less; they run in length from North to South, and in breadth from East to West. This Part of the World is said to have these remarkable Things. 1. All along the Coast, in the *Lanos*, it blows continually with one only Wind, which is South and South-west, contrary to that which usually blows under the *Torrid Zone*. 2. It never Rains, Thunders, Snows, or Hails, in all this Coast, or *Lanos*, though there falls sometimes a small Dew. 2. Upon the *Andes* it Rains almost continually, though it be sometimes more Clear

Clear than other. 4. In the *Sierras*, which lies betwixt both the Extreams, it rains from *September* to *April*, but in the other Seasons it is more clear, which is when the Sun is farthest off, and the contrary when it is nearest. Now the Reason of all seems to be this. The Eastern Breezes which blow constantly under the *Line*, being stop't in their Course by the *Sierras* and *Andes*, and yet the same Breezes being to be found in the *South-Sea* beyond *Peru*, as appears by the easy Voyages from *Peru* to the *Philippines*, a Current of Wind blows from the South on the Plains of *Peru*, to supply the Eastern Breeze in the *South-Seas*, and there being but one constant Gale in these Plains, and no contrary Winds, nor Hills for it to beat upon, this seems to be the Reason why the Vapours are never, or very seldom, driven into Rain. And the *Andes* being as high perhaps in many Places as the Vapours ascend in the highest Degree of the *Atmosphere's* Gravity, this may probably be the Reason why the Eastern Breeze, beating constantly against these Hills, occasion Rains upon them at all Seasons of the Year. And the *Sierras* being it seems lower than the *Andes*, therefore from *September* to *April*, when the Sun is nearest, and so the *Atmosphere's* Gravity less, and the Vapours lower, they are driven against the *Sierras* into Rain.

6. The Causes of those particular, various, uncertain, and unconstant Winds, which do blow in the Countries without the *Tropicks*, and that most frequently in mountainous Places, and more seldom in great Planes, such as *Poland*, I cannot so easily conjecture: but those general Winds which usually fall out every where about both *Equinoctials*, seem to proceed from some general Cause: and this I take to be the Change of the *Monsoons*, and *Trade Winds*, about these Times between the *Tropicks*. For there must needs be about these Seasons a Change of the Balance of the *Atmosphere*, according to what I have discoursed on the third Head, and this I think cannot but occasion strong Winds over all the Earth.

2. Dr. *Garden* endeavours to explain and give an Account of the Trade-winds within the *Tropicks*, from the different Gravity of the *Atmosphere* at divers times of the Year. And yet it is asserted by Dr. *Lister*, That the *Mercury* is not affected with the Weather, or very rarely, let it be cloudy, rainy, windy or serene, in *St. Helena* or the *Barbadoes*, and therefore probably not within the *Tropicks*, unless in a violent Storm or Hurricane. Now if the *Mercury* move little or nothing in the *Baroscope*, 'tis likely there is little or no Change in the Gravity of the *Atmosphere*, within the *Tropicks*.

3. The universal Ocean may most properly be divided into three Parts; viz, 1. The *Atlantick* and *Æthiopic* Sea. 2. The *Indian Ocean*. 3. The great *South Sea*, or the *Pacifick Ocean*.

1. In the *Atlantick* and *Æthiopic* Seas, between the *Tropicks*, there is a general Easterly Wind all the Year long, without any considerable variation; excepting that it is subject to be deflected therefrom, some few Points of the Compass, towards the North or South, according to the Position of the Place.

1. Near the Coast of *Africa*, as soon as you have passed the *Canary Isles*, you are sure to meet a fresh Gale of N. E. Wind, about the Latitude of 28° North, which seldom comes to the Eastwards of the E. N. E. or passes the N. N. E. This Wind accompanies those bound to the Southward, to the Latitude

By Mr. W. Molyneux. n. 177. p. 1237.

vid. Sed. X.

By Mr. Halley, n. 183. p. 153.

titude of 10° . North, and about 100 Leagues from the *Guinea Coast*, where till the 4° of North Latitude they fall into *Calms* and *Tornadoes*.

2. Those bound to the *Caribbe Isles*, find, as they approach the *American Side*, that the aforesaid N. E. Wind becomes still more and more Easterly, so as sometimes to be E. sometimes E. b. S. but yet most commonly to the Northward of the East, a Point or two, seldom more. 'Tis likewise observed, that the Strength of these Winds does gradually decrease, as you sail to the Westwards.

3. That the *Limits* of the *Trade* and *Variable* Winds in this *Ocean*, are farther extended on the *American* side than the *African*; for whereas you meet not with this certain Wind till after you have passed the Latitude of 28° on this side; on the *American* side it commonly holds to 30 , 31 , or 32° of Latitude; and this is verified likewise to the Southward of the *Equinoctial*, for near the *Cape of Good Hope*, the *Limits* of the *Trade Winds* are 3 or 4° nearer the Line than on the Coast of *Brasil*.

4. That from the Latitude of 4° North to the aforesaid *Limits* on the South side of the *Equator*, the Winds are generally and perpetually between the South and East, and most commonly between the South East and East, observing always this Rule, that on the *African* side they are more southerly, on the *Brasilian* more easterly, so as to become almost due East, the little Deflexion they have being still to the Southwards. In this Part of the *Ocean* it has been my fortune to pass a full Year, in an Employment that obliged me to regard more than ordinarily the Weather, and I found the Winds constantly about the South-east, the most usual Point *S. E. b. E.*; when it was Easterly it generally blew hard, and was gloomy, dark, and sometimes rainy Weather; if it came to the Southwards, it was generally serene, and a small Gale next to a Calm; but this not very common. But I never saw it to the Westwards of the South, or Northwards of the East.

5. That the Season of the Year has some small Effect on these *Trade-winds*, for that when the Sun is considerably to the northwards of the *Equator*, the South-east Winds, especially the Streight of this Ocean, (if I may so call it) between *Brasil* and the Coast of *Guinea*, do vary a Point or two to the Southwards, and the North-east become more Easterly; and on the contrary, when the Sun is towards the *Tropick of Capricorn*, the South-easterly Winds become more Easterly, and the North-easterly Winds on this side the Line were more to the Northward.

6. There is in this *Ocean* a Tract of Sea, wherein the Southerly and South-west Winds are perpetual, viz. all along the Coast of *Guinea*, for above 500 Leagues together, from *Sierra Leona* to the Isle of *St. Thomas*, for the South-east *Trade-wind* having passed the Line, and approaching the Coast of *Guinea*, within 80 or 100 Leagues inclines towards the Shore, and becomes *S. S. E.* and by Degrees, as you come nearer, it veers about to South, *S. S. W.* and in with the Land *South-West*, and sometimes *W. S. W.* which Variation is better expressed in the Map than it can well be in Words. These are the Winds which are observed on this Coast when it blows true, but there are frequent Calms, violent sudden Gusts called *Tornado's* from all Points of the

Compass,

Compass, and sometimes unwholsom, foggy, easterly Winds, called *Hermitae*, by the Natives, which too often infect the Navigation of these Parts.

7 That to the Northwards of the Line, between 4 and 10 *deg.* of *Latitude*, and between the Meridians of *Cape Verde*, and of the Eastermost Islands that bear that Name, there is a Tract of Sea, wherein it were improper to say there is any *Trade Wind*, or yet a *Variable*, for it seems condemned to perpetual Calms, attended with terrible Thunder and Lightning, and Rains so frequent, that our Navigators from thence call this Part of the Sea the *Rains*: the little Winds that are, be only some sudden uncertain Gusts, of very little Continuance and less Extent; so that sometimes each Hour you shall have a different Gale, which dies away into a Calm before another succeed; and in a Fleet of Ships in sight of one another, each shall have the Wind from a several Point of the Compass; with these weak *Breezes*, Ships are obliged to make the best of their way to the Southward thro' the afore-said six *Degrees*, wherein 'tis reported some have been detained whole Months for want of Wind.

From the three last Observables is shewn the Reason of two notable Occurrences in the *East-India* and *Guinea* Navigations. The one is, why notwithstanding the narrowest Part of the Sea between *Guinea* and *Brasil* be about 500 Leagues over, yet Ships bound to the Southward, sometimes, especially in the Months of *July* and *August*, find a great Difficulty to pass it. This happens because of the South-east Winds, at that time of the Year commonly extending some *deg.* beyond the ordinary Limit of 4 *deg.* North *Lat.* and withal they come so much southerly, as to be sometimes South, sometimes a Point or two to the West; there remains then only to plie to Windward, and if on the one side they stand away *W. S. W.* they gain the Wind still more and more easterly, but there is Danger of not weathering the *Brasilian* Shore, or at least the Shoals upon that Coast. But if upon the other Tack they go away *E. S. E.* they fall into the Neighbourhood of the Coast of *Guinea*, from which there is no departing without running Easterly, as far as the Isle of *St. Thomas*, which is the constant Practice of all the *Guinea* Ships, and which may seem very strange without the Consideration of the 6th Remark, which shews the Reason of it. For being in with the Coast, the Wind blows generally at *S. W.* and *W. S. W.* with which Winds they cannot go to the Northward for the Land, and on the other Tack, they can lie no nearer the Wind than *S. S. E.* or *S.* and with these Courses they run off the Shore, but in so doing, they always find the Winds more and more contrary; so that when near the Shore, they could lie South, at a greater distance they can make their way no better than *S. E.* and afterwards *E. S. E.* with which Courses they fetch commonly the Isle of *St. Thomas* and *Cape Lopez*, where finding the Winds to the Eastward of the South, they keep them favourable by running away to the Westward in the South *Lat.* 3 or 4 *Deg.* where the *S. E.* Winds are perpetual.

For the sake of these general Winds, all those that use the *West-Indian* Trade, even those bound to *Virginia*, count it their best Course to get as soon as they can to the Southwards, that so they may be certain of a fair and fresh

fresh Gale, to run before it to the Westwards; and for the same Reason those homewards bound from *America*, endeavour to gain the Latitude of 30 deg. as soon as possible, where they first find the Winds begin to be variable; tho' the most ordinary Winds in the northern Part of the *Atlantick Ocean* come from between the South and West.

As to those furious Storms called *Hurricanes*, which are as it were peculiar to the *Caribbe Isles*; and which so dreadfully afflict them in the Month of *August*, or not much before or after, they do not so properly belong to this Place, both by Reason of their small Continuance and Extent, as likewise because they are not Anniversary; some Years having more than one, and sometimes for several Years together there being none at all. But their Violence is so inconceivable, and their other *Phænomena* so surprising, that they merit well to be considered apart.

What is here said, is to be understood of the Sea-Winds, at some distance from the Land; for upon and near the Shores, the Land and Sea Breezes are almost every where sensible; and the great variety which happens in their Periods, Force and Direction, from the Situation of the Mountains, Vallies and Woods, and from the various Texture of the Soil, more or less capable of retaining and reflecting Heat, and of exhaling or condensing Vapours, is such, that it were an endless Task to endeavour to account for them.

2. In the *Indian Ocean*, the Winds are partly general, as in the *Æthiopick Ocean*, partly periodical, that is, half the Year they blow one way, and the other half near upon the opposite Points; and these Points and Times of shifting are different in different Parts of this Ocean.

1. Between the Latitudes of 10 deg. and 30 deg. South, between *Madagascar* and *Hollandia Nova*, the *General Trade-Winds* about the *S. E. b. E.* is found to blow all the Year long, to all Intents and Purposes after the same Manner as in the same Latitudes in the *Æthiopick Ocean*, as it is described in the 4th Remark foregoing.

2. That the aforesaid *S. E.* Winds do extend to within 2 deg. of the *Æquator* during the Months of *June*, *July*, and *August*, &c. to *November*, at which time between the South Latitudes of 3 and 10 Deg. being near the Meridian of the north End of *Madagascar*; and between 2 and 12 South Latitude, being near *Sumatra* and *Java*; the contrary Winds from the *N. W.* or between the North and West, set in and blow for half a Year, viz. from the Beginning of *December* till *May*: and this *Monsoon* is observed as far as the *Molucca Isles*, of which more anon.

3. That to the Northward of 3 Deg. South Latitude, over the whole *Arabian* or *Indian Sea* and *Gulf of Bengal*, from *Sumatra* to the Coast of *Africa*, there is another *Monsoon*, blowing from *October* to *April*, upon the *N. E.* Points; but in the other half Year, from *April* to *October*, upon the opposite Points of *S. W.* and *W. S. W.* and that with rather more Force than the other, accompanied with dark, rainy Weather, whereas the *N. E.* blows clear. 'Tis likewise to be noted, that the Winds are not so constant, either in Strength or Point, in the *Gulf of Bengal*, as they are in the *Indian Sea*, where

where a certain steady Gale scarce ever fails. 'Tis also remarkable, that the *S. W.* Winds in these Seas are generally more Southerly on the *African* side, more Westerly on the *Indian*.

4. There is a Tract of Sea to the Southwards of the *Æquator*, subject to the same changes of the Winds, viz. near the *African* Coast, between it and the Island *Madagascar* or *St. Lawrence*, and from thence Northwards as far as the *Line*; wherein from *April* to *October* there is found a constant Fresh *S. S. W.* Wind, which as you go more Northerly, becomes still more and more Westerly, so as to fall in with the *W. S. W.* Winds mention'd before in those Months of the Year to be certain to the Northward of the *Æquator*: What Winds blow in those Seas for the other Half Year, I have not yet been able to obtain to my full satisfaction: The account which has been given me is only this, that the Winds are much Easterly hereabouts, and as often to the North of the true East as to the Southwards thereof.

5. That to the Eastward of *Sumatra* and *Malacca*, to the Northwards of the *Line*, and along the Coast of *Camboia* and *China*, the *Monsoons* blow North and South; that is to say, the *N. E.* Winds are much Northerly, and the *S. W.* much Southerly. This Constitution reaches to the Eastwards of the *Philippine* Isles, and as far Northerly as *Japan*. The Northern *Monsoon* setting in, in these Seas, in *October* or *November*, and the Southern in *May*, blowing all the Summer Months. Here it is to be noted, that the Points of the Compass from whence the Winds come in these Parts of the World, are not so fixt as in those lately describ'd; for the Southerly will frequently pass a Point or two to the Eastwards of the South, and the Northerly as much to the Westwards of the North, which seems occasioned by the great quantity of Land which is interspersed in these Seas.

6. That in the same *Meridians*, but to the Southwards of the *Æquator*, being that Tract lying between *Sumatra* and *Java* to the West, and *New-Guinea* to the East, the same Northerly and Southerly *Monsoons* are observed; but with this difference, that the Inclination of the Northerly is towards the *N. W.* and of the Southerly towards the *S. E.* but the *Plage Venti* are not more constant here than in the former, viz. *Variable* 5 or 6 Points: Besides, the times of the change of these Winds are not the same as in the *Chinese* Seas, but about a Month or 6 Weeks later.

7. That these contrary Winds do not shift all at once, but in some places the time of the Change is attended with *Calms*, in others with *Variable* Winds; and it is particularly remarkable, that the End of the Westerly *Monsoon* on the Coast of *Coromandel*, and the two last Months of the Southerly *Monsoon* in the Seas of *China*, are very subject to be *Tempestuous*: The Violence of these Storms is such, that they seem to be of the Nature of the *West-India Hurricanes*, and render the Navigation of these Parts very unsafe about that time of the Year. These *Tempests* are by our Seamen usually termed, the *Breaking up of the Monsoons*.

By reason of the shifting of these Winds, all those that sail in these Seas, are oblig'd to observe the Seasons proper for their Voyages; and so doing they fail not of a Fair Wind and speedy Passage; but if so be they chance to out-stay their time, till the contrary *Monsoon* set in, as it fre-

quently happens, they are forced to give over the hopes of accomplishing their intended Voyages, and either return to the Port from whence they came, or else put into some other Harbour, there to spend the time till the Winds shall come favourable.

8. That Navigation that there is on the *Mare Pacificum* is by the *Spaniards*, who go yearly from the Coast of *New-Spain* to the *Manilba's*: But that is but by one beaten Tract; so that I cannot be so particular here as in the other two. What the *Spanish* Authors say of the Winds they find in their Courses, and what is confirm'd by the old accounts of *Drake* and *Candish*, and since by *Schooten*, who sailed the whole breadth of this Sea in the Southern *Latitude* of 15 or 16 deg. is, that there is a great Conformity betwixt the Winds of this Sea, and those of the *Atlantick* and *Æthiopic*; that is to say, that to the Northwards of the *Æquator*, the predominant Wind is between the *E.* and *N. E.* and to the Southwards thereof, there is a constant steady Gale between the *E.* and *S. E.* and that on both sides the *Line*, with so much Constancy that they scarce ever need to attend the Sails, and Strength; that it is rare to fail of Crossing this vast Ocean in ten Weeks time, which is about 130 Miles *per diem*: Besides, 'tis said that Storms and Tempests are never known in these Parts; Wherefore some have thought it might be as short a Voyage to *Japan* and *China*, to go by the *Streights* of *Magellan*, as by the *Cape* of *Good Hope*.

The Limits of these General Winds are also much the same as in the *Atlantick* Sea, viz. about the 30th degree of *Latitude* on both sides; for the *Spaniards* Homewards bound from the *Manilba's*, always take the advantage of the Southerly *Monsoon*, blowing there in the Summer Months, and run up to the Northwards of that *Latitude*, as high as *Japan*, before they meet with *Variable* Winds, to shape their Course to the Eastwards. And *Schooten* and others that have gone about by the *Magellan Streights*, have found the Limits of *S. E.* Winds, much about the same *Latitude* to the Southwards; besides, a farther Analogy between the Winds of this Ocean and the *Æthiopic* appears in that, that upon the Coast of *Peru* they are always much Southerly, like as they are found near the shores of *Angola*.

Fig. 20.

To help the Conception of the Reader in a matter of so much difficulty, I believ'd it necessary to adjoin a *Scheme*, shewing at one view all the various *Tracts* and *Courses* of these Winds. The Limits of these several *Tracts* are designed every where by prickt Lines, as well in the *Atlantick* and *Æthiopic*, where they are the Boundaries of the *Trade* and *Variable* Winds, as in the *Indian Ocean*, where they also shew the extent of the several *Monsoons*. The Course of the Winds is express'd by Rows of stroaks in the same Line that a Ship would move, going always before it; the sharp End of each little stroak pointing out that part of the *Horizon*, from whence the Wind continually comes; and where there are *Monsoons*, the Rows of the stroaks run alternately backwards and forwards, by which means they are thicker there than else-where. As to the great *South-Sea*, considering its vast extent, and the little Variety there is in its Winds, and the great Analogy between them, and those of the *Atlantick* and *Æthiopic-Oceans*; besides that the greatest part thereof is wholly unknown to us; I thought it unnecessary to lengthen the *Map* therewith.

In the foregoing History are contained several Problems, that merit well the Consideration of our acuteſt Naturaliſts, both by reaſon of the Conſtancy of the Effect, and of the immense Extent thereof; near half the Surface of the Globe being concerned; wherein if I am not able to account for all Particulars, yet 'tis hoped the Thoughts I have ſpent thereon, will not be judged wholly loſt by the Curious in Natural Inquiries.

1. *Wind* is moſt properly defined to be the Stream or Current of the Air; and where ſuch Current is perpetual and fixt in its Courſe, 'tis neceſſary that it proceed from a permanent unintermitting Cauſe, capable of producing a like conſtant Effect, and agreeable to the known Properties of the Elements of *Air* and *Water*, and the Laws of the Motion of fluid Bodies. Such an one is, I conceive, the Action of the Sun's Beams upon the *Air* and *Water*, as he paſſes every Day over the *Oceans*, conſidered together with the Nature of the Soil and Situation of the adjoining *Continents*. I ſay therefore, *Fiſt*, That according to the Laws of *Statics*, the Air which is leſs rarified or expanded by Heat, and conſequently more ponderous, muſt have a Motion towards thoſe Parts thereof which are more rarified, and leſs ponderous, to bring it to an *Equilibrium*; and, *Secondly*, That the Preſence of the Sun continually ſhifting to the Weſtwards; that Part towards which the Air tends, by reaſon of the Rarefaction made by his greateſt Meridian Heat, is with him carried Weſtward, and conſequently the Tendency of the whole Body of the lower Air is that way. Thus a *General Eaſterly Wind* is formed, which being impreſſed upon all the Air of a vaſt Ocean, the Parts impel one the other, and ſo keep moving till the next Return of the Sun, whereby ſo much of the Motion as was loſt is again reſtor'd, and thus the *Eaſterly Wind* is made *Perpetual*.

2. From the ſame Principle it follows, that this *Eaſterly Wind* ſhould on the North ſide of the *Æquator*, be to the Northwards of the Eaſt, and in South *Latitudes* to the South thereof; for near the *Line*, the Air is much more rarified, than at a greater diſtance from it; becauſe of the Sun's being twice in a Year vertical, and at no time diſtant above 23 deg. and a half, at which diſtance the Heat, being as the Sine of the Angle of Incidence, is but little ſhort of that of the perpendicular Ray. Whereas under the *Tropicks*, though the Sun ſtay long vertical, yet he is as long 47 deg. off; which is a kind of Winter, wherein the Air ſo cools, as that the Summer Heat cannot warm it to the ſame degree with that under the *Æquator*, wherefore the Air to the Northwards and Southwards, being leſs rarified than that in the Middle, it follows, that from both ſides it ought to tend towards the *Æquator*. This Motion compounded with the former *Eaſterly Wind*, answers all the *Phænomena* of the *General Trade-Winds*; which if the whole Surface of the Globe were Sea, would undoubtedly blow all round the World, as they are found to do in the *Atlantick* and *Æthiopic Oceans*.

3. But ſeeing that ſo great *Continents* do interpoſe and break the Continuity of the *Ocean*, regard muſt be had to the Nature of the Soil and the Poſition of the high Mountains, which I ſuppoſe the two principal Cauſes

of the several *Variations* of the *Winds*, from the former General Rule: For if a Country lying near the Sun prove to be Flat, Sandy, low Land, such as the *Deserts* of *Libya* are usually reported to be, the Heat occasioned by the Reflection of the Sun's Beams, and the Retention thereof in the Sand, is incredible to those that have not felt it; whereby the Air being exceedingly rarified, it is necessary that the cooler and more dense Air should run thitherwards to restore the *Æquilibrium*. This I take to be the Cause, why near the Coast of *Guinea* the Wind always sets in upon the Land, blowing Westerly instead of Easterly, there being sufficient Reason to believe, that the Inland Parts of *Africa* are prodigiously hot, since the Northern Borders thereof were so intemperate, as to give the Ancients Cause to conclude, that all beyond the *Tropick* was made *Uninhabitable* by Excess of Heat. From the same Cause it happens, that there are so constant *Calms* in that Part of the Ocean, called the *Rains*, (described in the 7th Remark on the *Atlantick Sea*;) For this Tract being placed in the middle, between the Westerly Winds blowing on the Coast of *Guinea*, and the Easterly *Trade Winds* blowing to the Westwards thereof, the Tendency of the Air here is indifferent to either, and so stands in *Æquilibrium* between both; and the Weight of the incumbent *Atmosphere* being diminished by the continual contrary Winds blowing from hence, is the Reason that the Air here holds not the copious Vapour it receives, but lets it fall into so frequent *Rains*.

4. But as the cool and dense Air, by reason of its greater Gravity, presses upon the hot and rarified, 'tis demonstrative that this latter must ascend in a continual Stream as fast as it rarifies, and that being ascended it must disperse it self to preserve the *Æquilibrium*, that is, by a *contrary Current*, the upper Air must move from those Parts where the greatest Heat is: So by a kind of Circulation, the *N. E. Trade Wind* below, will be attended with a *S. W.* above, and the *S. E.* with a *N. W.* Wind above. And that this is more than a bare Conjecture, the almost instantaneous Change of the Wind to the opposite Point, which is frequently found in passing the Limits of the *Trade Winds*, seems to assure us; but that which above all confirms this *Hypothesis* is the *Phænomenon* of the *Monsoons*, by this means most easily solved, and without it hardly explicable. Supposing therefore such a Circulation as above, 'tis to be considered that to the Northward of the *Indian Ocean* there is every where Land within the usual Limits of the *Latitude* of 30, viz. *Arabia*, *Perfia*, *India*, &c. which for the same Reason as the Mediterranean Parts of *Africa* are subject to unsufferable Heats when the Sun is to the North, passing nearly Vertical, but yet are Temperate enough when the Sun is removed towards the other *Tropick*; because of a Ridge of Mountains at some distance within the Land, said to be frequently in Winter covered with Snow, over which the Air, as it passes, must needs be much chilled. Hence it comes to pass, that the Air coming, according to the general Rule, out of the *N. E.* in the *Indian Seas*, is sometimes hotter sometimes colder than that which by this Circulation is returned out of the *S. W.* and by consequence, sometimes the under Current or Wind is from the *N. E.* sometimes from no other

other Cause, is clear from the Times wherein these Winds set in, viz. in *April*, when the Sun begins to warm those Countries to the North, the *S. W.* Monsoon begins, and blows during the Heats till *October*, when the Sun being retired, and all things growing cooler Northward, and the Heat increasing to the South, the *N. E.* Winds enter and blow all the Winter till *April* again.

5. And it is undoubtedly from the same Principle that to the Southwards of the *Æquator*, in part of the *Indian Ocean*, the *N. W.* Wind succeeds the *S. E.* when the Sun draws near the *Tropick of Capricorn*. But I must confess, that in this latter occurs a Difficulty not well to be accounted for, which is, why this Change of the *Monsoons* should be any more in this *Ocean*, than in the same *Latitudes* in the *Æthiopick*, where there is nothing more certain than a *S. E.* Wind all the Year.

6. 'Tis likewise very hard to conceive, why the Limits of the *Trade-wind* should be fixt about the 30th *Deg.* of *Latitude* all round the Globe; and that they should so seldom transgress or fall short of those Bounds; as also that in the *Indian Sea*, only the Northern Part should be subject to the changeable *Monsoons*, and in the Southern there be a constant *S. E.*

These are Particulars that merit to be considered more at large, and furnish a sufficient Subject for a just Volume.

XXXVII. Mr. *Henshaw* has observed, That *Dew* newly gathered, and filtered through a clean Linen Cloth, tho' it be not very clear, is of a yellowish Colour, somewhat approaching to that of Urine.

That having endeavour'd to putrify it, by putting several Proportions into glass Bodies with blind Heads, and setting them in several Heats, as of Dung, and gentle Baths, he quite failed of his Intention: for Heat, tho' never so gentle, did rather clarify and preserve it sweet, though continued for two Months together, than cause any Putrefaction or Separation of Parts.

That exposing of it to the Sun for a whole Summer in Glasses, that hold about 2 Gallons, with narrow Mouths that might be stopped with Cork, the only considerable Alteration he observed to be produced in it was, that store of green Stuff (such as is seen in Summer in Ditches and standing Waters) floated on the Top, and in some Places grew to the sides of the Glass.

That putting 4 or 5 Gallons of it into a half Tub, as they call it, of Wood, and straining a Canvas over it to keep out Dust and Insects, and letting it stand in some shady Room for 3 Weeks or a Month, it did of it self putrify and stink exceedingly, and let fall to the Bottom a black Sediment like Mudd.

That coming often to see what Alterations appeared in the Putrefaction, he observed, that at the Beginning, within 24 Hours, a slimy Film floated on the Top of the Water, which after a while falling to the bottom, there came another such Film in its Place.

That if *Dew* were put into long narrow Vessels of Glass, such as formerly were used for *Receivers* in distilling of *Aqua Fortis*, the slime would rise to that Height, that he could take it off with a Spoon; and when he had put a pret-

*Observations
upon May-
Dew; by Mr.
Tho. Henshaw, A. 3.
p. 33.*

ty Quantity of it into a Drinking-glass, and that it had stood all Night and the Water drained from it, if he had turned it out on his Hand, it would stand upright in Figure of the Glass, in Substance like boiled white Starch, tho' somewhat more transparent, if his Memory, *saith he*, fail him not.

That having once gotten a pretty Quantity of this Gelly, and put it into a Glass-body and Blind-head, he set it into a gentle Bath, with an Intention to have putrified it, but after a few Days, he found the Head had not been well luted on, and that some Moisture exhaling the Gelly was grown almost dry, and a large *Mushroom* was grown out of it within the Glass; it was of a loose watrish Contexture, such an one as he had seen growing out of rotten Wood.

That having several Tubs with good Quantity of *Dew* in them, set to putrify in the Manner abovesaid, and coming to pour out of one of them to make use of it, he found in the Water a great Bunch bigger than his Fist, of those Insects commonly called *Hog-lice*, or *Millepedes*, tangled together by their long Tails, one of which came out of every one of their Bodies about the Bigness of a Horse Hair. The Insects did all live and move after they were taken out.

That emptying another Tub whereon the Sun it seems had used sometimes to shine, and finding upon the straining it thro' a clean Linen Cloth two or three Spoonfuls of green Stuff, though not so thick nor so green as that above mentioned, found in the Glasses purposely exposed to the Sun, he put this green Stuff in a Glass, and tied a Paper over it, and coming some Days after to view it, he found the Glass almost filled with an innumerable Company of small Flies, almost all Wings, such as are usually seen in great Swarms in the Air in Summer Evenings.

That setting about a Gallon of this *Dew*, (which, he saith, if he misremember not, had been first putrified and strained) in an open jarre Glass with a wide Mouth, and leaving it for many Weeks standing in a South-window on which the Sun lay very much, but the Casements were kept close shut; after some time, coming to take Account of his *Dew*, he found it very full of little *Insects*, with great Heads and small tapering Bodies, somewhat resembling *Tadpoles*, but very much less. These on his Approach to the Glass, would sink down to the bottom, as it were, to hide themselves, and upon his Retreat, wriggle themselves up to the Top of the Water again. Leaving it thus for some time longer, he afterwards found the Room very full of *Gnats*, tho' the Door and Windows were kept shut. He adds, that he did not at first suspect that those *Gnats* had any Relation to the *Dew*, but after finding the *Gnats* to be multiplied, and the little watry Animals to be much lessened in quantity, and finding great numbers of their empty Skins floating on the Face of his *Dew*, he thought he had just Reason to persuade himself that the *Gnats* were by a second Birth produced of those little Animals.

That vapouring away great Quantities of his putrified Dew in Glass Basons and other earthen glazed Vessels, he did at last obtain, as he remembers, above 2 Pound of grayish Earth, which when he had washed with more of the same Dew out of all his Basons into one, and vapoured to Siccity, lay in
Leaves

Leaves one above another, not unlike to some kind of brown Paper, but very friable.

That taking this Earth out, and after he had well ground it on a Marble, and given it a smart Fire in a coated Retort of Glass, it soon melted and became a Cake in the bottom when it was cold, and looked as if it had been Salt and Brimstone in a certain Proportion melted together; but, as he remembers, was not at all *inflammable*. This ground again on a Marble, he saith, did turn Spring Water of a reddish purple Colour.

That by often calcining and filtering this Earth, he did at last extract 2 Ounces of a fine small white Salt, which looked on thro' a good Microscope, seem'd to have Sides and Angles in the same Number and Figure, as *Rock-Petre*.

XXXVIII. 1. We had of late in the County of *Limerick* and *Tipperary*,
Showers of a sort of Matter like Butter or Grease; if one rub it upon one's
Hand it will melt, but lay it by the Fire and it dries and grows hard, having
a very stinking Smell. Some of it fell here at *Kilkenny*, Nov. 14, 1695.
which I did see my self the next Morning.

A kind of Dew like Butter, in Ireland; by Mr. R. Vans, n. 220. p. 223.

2. Having very diligently enquired concerning a very odd Phænomenon, which was observed in many Parts of *Munster* and *Leinster*, the best Account I can collect thereof, is as follows; For a good Part of the Winter 1695, and Spring following, there fell in several Places a kind of thick Dew which the Country People call'd *Butter*, from the Consistency and Colour of it, being soft, clammy, and of a dark Yellow; it fell always in the Night, and chiefly in moorish low Grounds, on the Top of the Grass, and often on the Thatch of Cabbins; 'twas seldom observ'd in the same Places twice, it commonly lay on the Earth for near a Fortnight without changing its Colour, but then dried and turned black: Cattle fed in the Fields where it lay indifferently as in other Fields. It fell in Lumps, often as big as the end of one's Finger, very thin and scatteringly; it had a strong ill Scent, somewhat like the smell of Church-yards or Graves: And indeed we had during most of that Season very stinking Fogs, some Sediment of which might possibly occasion this stinking Dew, tho' I will by no means pretend to offer that a Reason of it. I cannot find that it was kept long, or that it bred any *Worms* or *Insects*: yet the superstitious Country People, who had scall'd or sore Heads, rubb'd them with this Substance, and said it healed them.

By the Bishop of Cloyne, ib.

XXXIX. Dec. 6, 1631, Being in the Gulf of *Volo*, riding at Anchor, about 10 of the Clock that Night, it began to rain Sand or Ashes, and continued till two of the Clock the next Morning. It was about two Inches thick on the Deck; so that we cast it over-board with shovels, as we did Snow the Day before. There was no Wind stirring when these *Ashes* fell; it did not fall only in the Places where we were, but likewise in other Parts, as Ships were coming from *St. John d'Acre* to our Port; they being at that Time 100 Leagues from us. We compared the Ashes together, and found them both one.

A Shower of Ashes, in the Archipelago; by Capt. Will. Badi-ly, n. 21. p. 377.

N. B. This Shower of Ashes was upon an Eruption of Mount *Vesuvius*.

XL. This

*A Shower of
Ivy Berries,
mistaken for
Wheat; by
Mr. W. Cole
n. 188. p.
281.*

XL. This City of *Bristol* and the Country round, is filled with Reports of raining Wheat about *Warminster* in *Wiltshire*, and other Places within 6 or 8 Miles of it, and many believe it. I have procured several Parcels of it, and find it to be the Seed of *Ivy Berries*, which from Towers and Churches, Chimneys, Walls, and high Buildings were lately by very fierce Tempests of Wind and Hail driven away from the Holes, Chinks and other Parts, where Birds had brought them, especially *Sterlings* and *Choughs*. It was (among many other prodigious Stories) confidently affirmed, that those Grains were found in the Hail, as Seeds in Comfits. I have by all ways I can imagine, examined and compared them with the Seeds of *Ivy-Berries*, by the Taste, Smell, Size, and Figure; with the Assistance of *Magnifying Glasses*, viewing them in both the superficial and inward Parts.

*A Shower of
Fishes in
Kent; by Dr.
Rob. Cony.
n. 243. p.
289.*

XLI. On *Wednesday* before *Easter*, an. 1696, a Pasture Field at *Cranstead* near *Wrotham* in *Kent*, about two Acres, which is far from any part of the Sea or Branch of it, and a Place where are no Fish-ponds, but a Scarcity of Water, was all over-spread with little Fishes conceived to be rained down, there having been at that time a great Tempest of Thunder and Rain. The Fishes were about the length of a Man's little Finger, and judged by all that saw them to be young Whittings, many of them were taken up and shewed to several Persons. The Field belonged to one *Ware* a Yeoman, who shew'd some of them, among others, to Mr. *Lake* a Benchet of the *Middle Temple*, who had one of them, and brought it to *London*. The Truth of it was averr'd by many that saw the Fishes lie scattered all over that Field, and none in the other Fields thereto adjoining. The Quantity of them was estimated to be about a Bushel, being all together.

I had this Account from a worthy Gentleman of this Country, who had a Box-full of the Fishes.

*Hailstones
of an extraor-
dinary Big-
ness; by Dr.
Nath. Fair-
fax, n. 26.
p. 481.*

XLII. *July* 17, 1666, About ten in the Forenoon, there fell a violent Storm of Hail upon the Coast-Towns of *Suffolk*, tracing along *Seckford Hall*, *Woodbridge*, *Snapebridge*, *Aldborough*, &c. more to the Northwards. The Hail was small near *Yarmouth*; but at *Seckford-Hall*, one Hail-stone was found by Measure to be 9 Inches about. One of this Town (*viz Woodbridge*) found one at *Melton*, 8 Inches about. At *Snapebridge* a Man affirmed, that he lighted on one about 12 Inches about. A Lady of *Friston-Hall* putting one of them into a Balance, found it weigh 12s. 6d. Several Persons of good Credit in *Aldborough* affirmed some Hail-stones to have been full 'as big as *Turkeys Eggs* (an ordinary *Hen's Egg* weighs but about 9s.) *J. Baker* of *Rumbrough*, had his Head broken by the Knocks of them thro' a stiff Country Felt; in some Places his Head bled, in others Bunneys arose: The Horses were so pelted, that they hurried away his Cart beyond all Command. They seemed all white, smooth without, shining within. 'Tis somewhat strange, methinks, that their Pillar of Air should keep them aloft, if they were

were not clapt together in the falling, especially at such a Time of the Year when the Air is less thickned, and its Springs weaker.

XLIII. In May, 1686, there fell at *Lisle* in *Flanders*, Hail of so great a Bigness, that the least exceeded Pigeon's Eggs. Several of them were a Quarter of a Pound Weight and more. One among the rest was observed to contain a dark-brown Matter in the middle thereof, and being thrown into the Fire, it gave a very great Report. Others were transparent, which melted before the Fire immediately. This Storm passed over the Citadel and Town, and left not a whole Glass in the Windows on the windward side. The Trees were broken, and some beat down; and the *Partridges* and *Hares* kill'd in abundance.

Large Hail-stones in Flanders; by .. n. 203. p. 858.

XLIV. 1. A very extraordinary Hail fell in these Parts Apr. 29, 1697. The Vapour that disposed the aqueous Parts thus to congeal came with a South-west Wind out of *Carnarvanshire*, passing near *Snowdon* with a horrid black Cloud attended with frequent *Lightnings* and *Thunder*. As yet I hear no further of it Westward than out of *Denbighshire*, where it left *St. Asaph* to the Right, and did much Damage between it and the Sea, breaking all the Windows on the Weather-side, and killing Poultry and Lambs, and at *Sir John Conway's* at *Desert*, a stout Dog; and in the North Part of *Flintshire* several People had their Heads broke, and were grievously bruised on their Bodies. From *Flintshire* it crossed over the Arm of the Sea that comes up to *Chester*, and was only felt in *Cheshire*, at the very N. W. Corner of the *Peninsula* call'd *Wiral*, between the *Æstuaria* of *Chester* and *Leverpoole*, at a Town call'd *W. Kirby*, where it hailed but for three Minutes, it being on the extream Point thereof, on the Right-hand, but it thundred dreadfully, and was here at *Chester* about three in the Afternoon; but the main Body of it fell upon *Lancashire*, in a right Line from *Ormskirk* to *Blackborn*, which is on the Borders of *Yorkshire*; but whether it crossed the Ridge of Hills into *Yorkshire*, we know not. The Breadth of the Cloud was about two Miles; within which Compass it did incredible Damage, killing all sorts of Fowl and small Creatures, and scarce leaving any whole Panes in any of the Windows where it passed; but which is worse, it plowed up the Earth, and cut off the Blade of the green Corn so as utterly to destroy it, the *Hail-stones* burying themselves in the Ground; and the Bowling-Greens, where the Earth was any thing soft, were quite defaced, so as to be rendred unserviceable for a Time. This I had from an Eye-Witness. The *Hail-stones* some of which weighed five Ounces, were of differing Forms, some round, some half-round, some smooth, others embossed and crenulated, like the Foot of a drinking Glass, the Ice very transparent and hard, but a snowy Kernel was in the midst of most of them, if not all; the Force of their Fall argued them to fall from a great Height. What I take to be most extraordinary in this Phenomenon is, that such a sort of Vapours should continue undisperst so long a Tract, as above sixty Miles together, and in all the Way of its Passage occasion so extraordinary

Extraordinary Hail in Wales, Cheshire, &c. by Mr. Edm. Halley, n. 229. p. 570.

dinary a *Coagulation* and *Congelation* of the watry Clouds, as to encrease the *Hail-stones* to so vast a Bulk in so short a space as that of their Fall.

By ... ib.
P. 572.

2. We had only the extream Skirt of the Shower here, and there fell not above 10 *Hail-stones* in our Court, but they were much larger and harder than the oldest of us had seen. A Gentlewoman found one of them by Measure to be about 5 Inches about. A little while after the Shower was over, I found the *Stones* had fallen at good distances one from another, and that they were melting very fast, the Weather being very hot; scarce any of them was so little as a Musquet Bullet, but most of them far bigger, and of that Figure.

A Servant who was then at *Bootle-Mill*, tells me, That the Sea seemed to be risen to an unwonted height, and to bear the Appearance of a Wood; That he found *Hail-stones* as big as *Poot Eggs*. And that many Sea-Fowl and Land-Fowl were killed: and as an Instance of it, he took up a *Sea-swallow* on *Bootle Marsh*, whose Wing was broken with an icy Pellet, and brought her home. Upon this Story, I rid towards the Grounds which had shared most in the Storm. When I came to *Bootle*, I saw *Jane Mutche's* Windows ill batter'd; I found the Storm had been as violent at *Linaker*, I saw what Breaches it had made upon *Will. Halsall's* Barns, what Boughs it had broke off from his Appletrees, and what Wounds the *Hail-stones* had made in the green Brow by his House. I measured several of the Holes, and found them generally an Inch deep, and some an Inch and a half. *Will. Halsall* told me, that the great *Stones* fell so violently into the Marl-pit besides his House, that spouts of Water rose a Yard and a half high. This unriddled my Man's Story, that the Sea appeared like a Wood. Dr. *Tarleton* took up *Hail-stones* as big as *Duck Eggs* upon *Aughton Common*; and Mr. *Shepherd* professes, that the Church-yard at *Septon* seem'd as strew'd with *Duck Eggs*; and that one of them was weigh'd, which amounted to full half a Pound; two *Hail-stones* were weigh'd at *Ormskirk*, which came to $\frac{1}{2}$ of a Pound a-piece. At *Ince* the *Stones* were part as big as *Duck*, and part as *Goose Eggs*.

I sent some People the next Morning early to the Sea-side, and they brought in seven sorts of Fowls, as *Curlew*, *Sea-Pye*, *Sea-Swallow*, *Gorre*, and other we want Names for: and we hear that at the little Towns next the Sea, they were pick'd up by Bushels.

No *Hail* fell at *Everton*, *Lowhill*, or *Liverpoole*, the Storm ending near *Walton*, but there was so thick a Darkness before the Storm, that in *Liverpoole*, many People ran out of their Houses into the Street to look at the Face of the Sky; and it was marvellous dark here. The Neighbours tell doleful Stories of the Effects of this Hail; As a young Woman at *Bootle* was running for Shelter, her Hat fell off, and a *Hail-stone* that hit her behind the Ear made her tumble; a Man was knock'd off his Horse by the *Hail*, but presently got up again; Another having pull'd down his Hat to save his Face, a *Stone* fell which tore the Brim from the Crown, so far that he could put his Hand thro' the Hole; at *Ormskirk* 4 Pounds Damage was done to one Inn, and the Glass broke by the Storm in the whole Town could not be repaired for 60*l*. The *Stones* there rebounded, many of them 2 Yards high;

high; at *Ince* two Horses were knockt down in the Plough, and a Man fell at the same time; at *Crosby* some Beasts were knock'd down; One *Jo. Holland* was found dead in *Skirmsdale* after the Shower, but whether by the *Hail* or *Lightning* (for it came with *Thunder* and *Lightning*) I have not yet heard; Two Women were so beaten by it, in a little while before they got Cover, that they could hardly turn them in their Beds next Morning; They could hardly pass the Lanes for Baskets, Panniers, Sacks, and People, which the Horses had thrown down in their Return from *Ormskirk* Market.

XLV. On *Tuesday, May 4, 1697*, (at *Hitchin* in *Hartfordshire*) about 9 a Clock in the Morning, it began to lighten and thunder extreamly, some great Showers intervening; it continued till about two of the Clock in the Afternoon, when on a sudden a black Cloud arose S. W. of us, the Wind being East, and blew hard, then fell a sharp Shower, with some *Hail-stones*. I measured some of them 7 and 8 Inches about: but the Extremity of the Storm fell about *Offley*, where a young Fellow was kill'd, one of his Eyes stuck out of his Head, his Body was all over black with the Bruises; another Person nearer to *Offley* escaped with his Life, but much bruised; there was in the House of Sir *Jo. Spencer*, 7000 Quarries of Glafs broke, and there was great Damage done to all the neighbouring Houses thereabouts; the Hail fell in such vast Quantities, and so great, that it tore up the Ground, split great Oaks and other Trees in great Numbers; it cut down great Fields of *Rye*, as with a Scythe, and has destroy'd several hundred Acres of Wheat, Barley, &c. infomuch that they plough it up and sow it with Oares. The *Tempest* was such when it fell that in 4 Poles of Land, from the Hills near us, it carried away all the Staple of the Land, leaving nothing but Chalk; the Hail broke vast Numbers of Pigeons Wings, Crows, Rooks, and other Birds: the Flood came down, spreading 4 or 5 Acres of Land, rowling like the Bay of *Biscay*; and which is very strange, all this fell in the Compass of one *English* Mile. I was walking in my Garden, which is very small, perhaps about 30 Yards square, and before I could get out, it took me to my Knees, and was through my House before I could get in, which I can modestly speak was in the space of a Minute, and went thro' all like a Sea, carrying all Wooden Things like Boats on the Water, the greatest Part of the Town being under this Misfortune; the Surprise was so great, that we had scarce Time enough to save our Children and Wives. There fell some hundred thousand Cart-loads: I saw them 4 Days after, and if the Beds of Hail had not been broke by Peoples coming, and trampling of Horses, it might have lain till *Michaelmas*. They have been measured from one to thirteen and fourteen Inches certain: Some People talk largely of it, seventeen and eighteen Inches; but the other is certain Truth. The Figures of them are various, some oval, others round, others picked, some flat. We were not so curious to weigh them. The Damage about us, and in our Town, is near 4000 l.

A Storm of Hail in Hertfordshire, May 4, 1697, by Mr. Rob. Taylor, ib. p. 577.

XLVI. 1. In the Parish of *Westbide*, not far from *Hereford*, there fell on the 6th of *June, 1697*, so great a Quantity of *Hail*, that it destroy'd all the Poultry, Garden-stuff, Corn, Grass, and most of the Fruit-trees in the Parish,

A Storm of Hail in Herefordshire, June 6, 1697; by ... ib. 579

but killed no Men nor Cattle; but hurt several, and broke most of the Windows. Many of the Stones were measured above nine Inches in Compass.

By Mr. Edw.
Lhwyd, *ib.*

2. We had at *Ponty Pool* in *Monmouthshire*, *June 6, 1697*, an extraordinary Shower of *Hail*, which extended about a Mile, and lasted near half an Hour. It broke the Stalks of all the Beans and Wheat within that Circumference, and ruined as much Glass at Major *Hanbury's* House, as cost four Pounds repairing; some of the *Hail* were eight Inches about, their Figure very irregular and unconstant, several of the *Hail-stones* being compounded.

An unusual
sort of Snow;
By Mr. Joh.
Chr. Beck-
man, n. 39.
P. 773.

XLVII. The first of *March, 1667*, there fell an unusual sort of Snow at *Frankfort* in the *Oder*: It had none of the ordinary Figures, but was made up of little Pillars, whereof some were *Tetragonal*, some *Hexagonal*, with a neat *Basis*. On the Top they were somewhat larger, as the *Heads of Columns* are. Considering the whole Shape, we thought fit to give it the Name of *Nix Columnaris*.

Red Snow
near Genoa;
communicat-
ed by Sig.
Sarotti, n.
139. p. 976.

XLVIII. On *St. Joseph's Day*, upon the Mountains called *Le Langhe*, there fell upon the white Snow that was there already, a great Quantity of red, or if you please, of bloody Snow; from which, (being squeez'd) there came a Water of the same Colour.

Observations
on Snow; By
Dr. J. Beale,
n. 56. p.
1138.

XLIX. I have seen the Water of dissolved Snow perform a quick Cure, in taking out the Fire when the Flesh was burnt by a Warming-pan of Brass, which Metal commonly makes the Burning more difficult to be cured: Which did put me in Mind to examine the Figures of the Snow which now fell in this extreme Frost. I expected that we might see through the small Particles at least as through Lice, Fleas, Cheese-mites, &c. by some kind of Transparence: But I was deceived; my Assistants could make nothing of it, either by an ordinary or extraordinary Microscope.

The Nature
of Snow; By
Dr. Nehem.
Grew, n. 92.
p. 5193.

L. He that will enquire of the Nature of Snow, will do it best, not by the Pursuit of his Fancy in a Chair, but with his Eyes abroad; where if we use them well fixed, and with good Caution, and this in a thin, calm and still Snow, we may by Degrees observe,

1. With M. *Des Cartes* and Mr. *Hook*, that many Parts hereof are of a regular Figure for the most Part, as it were, so many little Rowels, or Stars, of six Points, being perfect and transparent *Ice*, as any we see upon a Pool or Vessel of Water. Upon each of these six Points are set other collateral Points, and those always at the same Angles as are the main Points themselves.

2. Amongst these regular Figures, many others alike regular, but far less, may likewise be discovered.

3. Looking still more warily we shall perceive, that there are divers others indeed irregular, yet chiefly but the broken Points, Parcels and Fragments of the regular ones.

Lastly, That besides the broken Parts, there are some others which seem

to have lost their Regularity, not so much in being broken as by various Winds, first gently thaw'd, and then froze into little irregular Clumpers again.

From whence the true Notion and external Nature of *Snow* seemeth to appear, viz. That not only some few Parts of *Snow*, but originally the whole Body of it, or of a *snowy* Cloud, is an infinite Mass of *Icicles* regularly figur'd; not one Particle thereof, I say, originally, not one of so many Millions, being indeterminate or irregular; that is to say, a Cloud of Vapours being gathered into Drops, the said Drops forthwith descend; upon which Descent, meeting with a soft freezing Wind, or at least passing through a colder Region of the Air, each Drop is immediately froze into an *Ice*, shooting it self forth into several Points or *Striae* on each Hand from-ward its Center: But still continuing their Descent, and meeting with some sprinkling and intermixed Gales of warmer Air, or in their continual Motion, and Wastage to and fro touching upon each other, some are a little thaw'd, blunted, frosted, clumper'd, others broken, but the most hanked and clung in several Parcels together, which we call *Flakes* of *Snow*.

Hence we understand why *Snow*, though it seems to be soft, yet 'tis truly hard, because true *Ice*; the inseparable Property whereof is, to be hard; seeming only to be soft, because upon the first Touch of the Finger upon any of its sharp Edges or Points, they instantly thaw, or otherwise they would pierce our Fingers as so many Lancets.

Why again, though it be true *Ice*, and so a hard and dense Body, yet very light; because of the extream Thinness of each *Ice* in Comparison of its Breadth. For so Gold, which, though of all Bodies the most ponderous, yet being beaten into Leaves, rides upon the least Breath of Air.

Also how it is White; because consistent of Parts all of them singly transparent; but being mixed together appear white, as the Parts of Froth, Glass, Ice, and other transparent Bodies, whether soft or hard.

The *essential* Nature of *Snow*, I think may be best understood, by comparing its general Figure with such regular Figures as we see in divers other Bodies; in that where we see the like Configurations, we may believe there is the like *Subject* wherein, or the like *Efficient* whereby, both those and these are made.

As for the *Figure* of *Snow*, 'tis generally one, viz. That which is above described: Rarely of different ones, which may be reduced chiefly to two Generals, Circulars and Hexagonals either simple or compounded together: More rarely, either to be seen of more than six Points, but if so, then not of eight or ten, but twelve: Or in single Shoots, as so many short slender Cylinders like those of *Nitre*: Or by one of these Shoots, as the Axle-tree, and touching upon the Center of a Pair of pointed *Icicles*, joyned together as the two Wheels: Or the same Hexagonal Figure, and of the same usual Breadth, but continued in Thickness or Profundity, like the Stone, which, as I remember, *Boetius* calls *Astroites*. All these I say are rare, the first described being the general *Figure*.

As for the *Configurations* of other Bodies, we shall find, that there are divers which have some a less, others a more near Resemblance herunto.

Nitre

Nitre is formed, as is commonly known, into long Cylindrical Shoots, as also all *Lixivial Salts*, for the most Part; resembling, though not perfectly, the several Points of each starry *Icicle* of *Snow*. *Salt of Harts Horn*, *Sal-Armoniac*, and some other *Volatile Salts*, besides their main and longer Shoots, have others shorter branched out from them; resembling as those the Main, so these the Collateral Points of *Snow*. But the *Icicles* of *Urine* are still more near: For, in *Salt of Harts-Horn*, although the Collateral Shoots stand at acute Angles with the Main, yet not by Pairs at equal height; and in *Sal-Armoniac*, although they stand diametrically opposite, or at equal height, yet withal at Right, not Acute Angles; whereas in the *Icicles* of *Urine* they stand at equal height, and at Acute Angles both: In both, like those of *Snow*. And it is observable, that the *Configuration* of *Feathers* is likewise the same: the reason whereof is, because Fowls having no Organs for the Evacuation of *Urine*, the *urinous* Parts of their Blood are evacuated by the Habit or Skin, where they produce and nourish *Feathers*.

From hence it should seem, That every Drop of Rain aforesaid, containing in it self some *Spirituos* Particles (as from the height to which they are advanced, the prolific Virtue of *Rain*, and its easy Tendency to Putrefaction above other Water, is argued they do,) and meeting with others in their Descent of a *Saline*, and that partly *Nitrous*, but chiefly *Urinous*, or of an *Acidosalinous* Nature, the said *Spirituos* Parts are apprehended by them, and with those the Watry, and so the whole Drop is fixed; yet not into any indifferent and irregular Shape, depriving the *Spirituos* Parts of their Motion in an instant; but according to the *Energy* of the *Spirituos* as the Pencil, and the specifick Nature or determinate Possibility of the *Saline* Parts as the Ruler, 'tis thus figured into a little Star.

A Freezing
Rain in So-
merfetshire;
by Dr. J.
Beal, n. 90.
p. 5138.

LI. 1. The *Freezing Rain*, which fell here the 9th, 10th, or 11th, of *December* 1672, (for I cannot confine the Time exactly) hath made such a Destruction of Trees, in all the Villages and Highways from *Bristol* towards *Wells*, and towards *Shepton-Mallet*, and towards *Bath* and *Bruton*, and in other Places of the *West*, that both for the Manner and Matter it may seem incredible; and is more strange than I have found in any *English* Chronicle. You have the Proof and Manner and best Measure of it in the following Transcript: "The late Prodigious Frost, (saith a very worthy Person of unquestionable Credit) hath much disabled many old Orchards, exposed to the North-east; had it concluded with some Gusts of Wind, it might have been of sad Importance; I weighed the Sprigg of an Ash-Tree of just three Quarters of a Pound, which was brought to my Table; the Ice on it weighed 16 Pounds, besides what was melted off by the Hands of them that brought it. A very small Bent at the same time was produced, which had an *Icicle*, encompassing it, of 5 Inches round by measure. Yet all this while, when Trees and Hedges were loaden with Ice, there was no Ice to be seen on our Rivers, nor so much as on our standing Pools. The like, or worse and more strange Complaints,

plaints, I received from several other Places, and from Eye-Witnesses of Credit. Some Travellers were almost lost by the Coldness of the *Freezing Air*, and *Freezing Rain*. All the Trees, Young and Old, on the Highway from *Bristol* to *Shepton*, were so torn and thrown down on both sides the Ways, that they were unpassable. By the like Obstructions the Carriers of *Bruton* were forc'd to return back. Some were affrighted with the Noise in the Air, till they discern'd that it was the clatter of *Icy Boughs*, dashed one against another by the Wind. Some told me that riding on the Snowy Downs, they saw this *Freezing Rain* fall upon the Snow, and immediately *Freeze to Ice*, without sinking at all into the Snow; so that the Snow was covered with *Ice* all along, and had been dangerous, if the *Ice* had been strong enough to bear them. Others were on their Journey when the *Ice* was able to bear them in some Places, and they were in great Distress.

Dec. 8. Much Snow fell here; the 9th much *Rain* fell here; and all the Snow passed away, not leaving an *Icicle* amongst us. The 10th Day, we had sudden Fits of Cold and relaxing Warmness. On *Wednesday (Dec. 11.)* I saw a Young Man, who returning home from a Journey of 5 Miles, and coming into a warm Room, cry'd out of extream Torments in all Parts of his Body. He affirmed, that the Air, and the Winds (which were then somewhat high) were so unsufferably Cold, that he was in utter Despair of coming home alive; yet all that Day nothing but moist Dew fell under our Feet. If we say, the Earth did send forth warm Steams to keep this *Freezing Rain* dissolved on her Surface; whence shall we say, the Air, and Rain and Winds got these *Freezing Icicles*, which oppressed Men and Plants? When the Candied *Frosts* do cover our Fruit-Trees perfectly white (as I have oft-times seen it hold for some Weeks together) it is so far from doing hurt to the Trees, that we have it in a Proverb for a good Sign of abundance of Fruit, in the ensuing Year: But this *Freezing Rain*, as soon as it touched any Bough, settled into *Ice*, and by multiplying and enlarging the *Icicles* (especially where it could lay hold on Moss or other asperities of the Tree, it broke all down with the Weight.

This shews that a *Frost* may be very fierce and dangerous in the Air, and on the Tops of some Hills and Plains, whilst in many other Places it keeps at two, three, or four Foot distance above the Ground, Rivers and Lakes; and many wander, at some Difference of Time, in some Places very furious; in other Places intermediate and not far asunder, very remiss and abated; where it was fierce always at the height of Trees at least, never on the Ground vehement, that I could hear of, but on *Salisbury Plains*, which are very high Grounds. n. 116.
p. 317.

As soon as these *Frosts* were over, we had glowing *Heats*, which caused a general Complaint amongst us of excessive Sweating, by Night and Day. n. 90.
p. 3140. The Bushes and many Flowers in the Garden appeared in such Forwardness, as if it were in *April* or *May*. I saw young *Coleworts* growing; and not far from my Abode, an Apple-tree blossomed before *Christmas*. This I do not mention for extraordinary; but I think 'tis more than ordinary, that before
New-

New-Years-Tide this Apple-tree bore Apples perfectly knitted, and as big as one's Finger's End.

At Oxford;
by Dr. Wal-
lis, n. 92. p.
5195. n. 231.
p. 654.

2. The like strange Frost was with us at *Oxford*. It was rather a *Raining of Ice*, or at least *Raining Freezing* as it fell; which made strange *Icicles* hanging on Trees, and a strange Noise by the rattling of them upon the Boughs Motion by the Wind; but not so much as at the Places you mention in *Somersetshire*. Yet more in the Country about us (as from several Relaters I have heard,) than with us here. And the great *Warmth* soon after was also with us; insomuch that not only Blossoms, but (as was then certainly affirmed, though I was not so curious as to get a Sight of any,) green Apples were observed on divers Trees, particularly in the Parish of *Holywell*.

Effects of
Cold in the
Northern
Countries; by
M. J. Schefferus, n. 19.
p. 350.

LII. 1. Mr. *John Schefferus*, a Professor in the *Swedish University* at *Upsal*, writes, That he had seen and had *Hares*, which about the Beginning of *Winter* and *Spring* were half *white* and half of their native Colour: That in the midst of *Winter* he never saw any but all *white*. That *Foxes* also are *white* in *Winter*, and *Squirrels* greyish mixt of a *dark* and *white* Colour.

That *Fishes* are killed by reason of the *Ice* not being broken: But first, in Ponds only or narrow Lakes, next, in such Lakes only where the *Ice* is pretty thick; for, where 'tis thin, they die not so easily: Lastly, that those *Fishes* that lie in slimy or clayie Ground die not so soon as others.

That in great Lakes, when 'tis a very bitter *Frost*, *Ice* is wont to be broken either by the Force of the Waves, or of the imprisoned Vapours, raised by the Agitation of the Water, and then bursting out with an Impetuosity, witness the Noise made by the Rupture of the *Ice* through the whole Length of such Lakes, which he affirms to be not less terrible than if many Guns went off together. Whereby it falls out, that *Fishes* are seldom found dead in great Lakes.

That neither Oil nor a strong Brine of Bay-Salt, is truly congealed into *Ice* in those Parts: That the *Frost* pierces into the Earth two Cubits or *Swedish Ells*, and what Moisture is found in it, is white, like *Ice*. That Waters, if standing, freeze to a greater Depth, even to three such *Ells* or more; but those that have a Current, less: That rapid Waters freeze not at all, nor ever bubbling Springs; and that these latter seem even to be warmer in *Winter* than in *Summer*.

By M. Febre,
ib. 531.

2. M. *Febre*, Chief Secretary to Prince *Radzivil*, assures us, that in the War against the *Muscovites* and *Cossacks* in *Jan. 1655* at the Siege *Bichow* in *White-Russia*, all their Provisions of *Spanish Wines* or *Peterfimen*, and Beer, were in one Night frozen upon the Sledge, notwithstanding they were covered with Straw; insomuch that they were constrained to carry them into a Stove to thaw them, which they could not do in two whole Days, and were obliged to break the Vessels, and put Pieces of the *Ice-Wine* into Kettles, to thaw them over the Fire for Drink. But he observed that the *Hungarian Wine* resisted the Cold better than the *Peterfimen*; for it was not so much frozen, unless it be that the Butler transported it sooner into the Stove. That the Scrue of a Flagon of *Aqua Vite* being put to his Mouth, stuck close to his Lips that he could not draw it off without drawing Blood.

That

That the Pool of the Village (where they quartered) was so thoroughly frozen, that there was but very little Water left between the Ice and the Bottom.

That Jan. 2, 1665, the Frost was so bitter in Poland, that three Soldiers dy'd of it in passing a long Ditch; and that divers Persons lost some of their Limbs.

LIII. 1. The past Winter 168 $\frac{1}{2}$ has been so severe in my Territories, and where it could expugn the more defensible and such as were inclosed, it has ravag'd all that lay open, and were abroad, without any Mercy.

As to *Timber-Trees*, I have not many here of any considerable Age or Stature, except a few *Elms*, which (having been decayed many Years) one cannot well find to have received any fresh Wounds, distinguishable from old Cracks and Hollownesses; and indeed I am told by divers, that *Elms* have not suffered as the great *Oaks* have done; nor do I find amongst innumerable of that Species (*Elms*) which I have planted, and that are now about twenty five and thirty Years standing, any of them touched: The same I observe of *Limes*, *Walnuts*, *Ash*, *Beach*, *Horn-beams*, *Birch*, *Chestnut*, and other Forresters. But, as I said, mine are young comparatively; and yet one would think, that should less protect them, because more tender: So as it seems the Risting so much complain'd of, has happen'd chiefly among the over-grown Trees, especially *Oaks*. My Lord *Weymouth* made his Lamentation to me, and so has the Earl of *Chesterfield*, Lord *Ferrers*, Sir *William Ferrer*, and others concerned in the same Calamity; which I mention, because of their distant Habitations. But if rightly I remember, one of these Noble Persons lately told me, that since the *Thaw*, the Trees which were exceedingly split, were come together and closed again; and I easily believ'd it: but that they are really as solid as before, I doubt will not appear, when they shall come to be examined by the Ax, and converted to Use. Nor has this Accident happen'd only to standing Timber, but to that which has been fell'd and season'd, as Mr. *Shish*, the Master-builder in his Majesty's Ship-Yard here, inform'd me.

The Effects of the Frost 1683-4; by Mr. J. Evelyn, n. 158. p. 559.

As for *Exotics*; I fear my *Cork-Trees* will hardly recover. The *Constantinopolitan* or *Horse-Chestnut* is turgid with Buds, and ready to explain its Leaf. My *Cedars* I think are lost: The *Ilex* and *Scarlet-Oak* not so: The *Arbutus*, doubtful, and so are *Bays*; but some will escape, and most of them repullulate and spring afresh, if cut down near the Earth, at the latter End of the Month. The *Scotch-Fir*, *Spruce*, and white *Spanish* (which last uses to suffer in their tender Buds by the *Spring-Frosts*) have received no Damage this Winter, I cannot say the same of the *Pine*, which bears the greater Cone, but other *Norways* and *Pinasters* are fresh. *Laurel* is only discoloured, and some of the woody Branches mortified, which being cut to the quick will soon put forth again, it being a succulent Plant. Amongst our *Shrubs*, *Rosemary* is intirely lost, and so universal (I fear) is the Destruction of this excellent Plant (not only over *England*, but our Neighbour Countries more Southward) that we must raise our next Hopes from the Seed. *Halimus*, or Sea-Purslain, (of which I had a pretty Hedge) is also perished, and so another of *French-Furzes*: The *Cypresses* are all of them scorched, and

some to Death, especially such as were kept shorn in Pyramids; but amongst great Numbers, there will divers escape, after they are well *chastiz'd*, that is, with a tough Hazel or other Wand, to beat off their dead and dusty Leaves, which growing much closer than other Shrubs, hinder the Air and Dews from refreshing the interior Parts. This Discipline I use to all my *Tonfile Shrubs* with good Success, as oft as a Winter parches them. The Berry-bearing *Savine* (which if well understood and cultivated were the only best *Succedaneum* to *Cypress*) has not suffered in the least; it perfectly resembles the *Cypress*, and grows very tall and thick. I think the *Arbor Thuya* is alive, and so is the *American Acacia*, *Acanthus*, *Paliurus*, *Pomgranate*; my *Laurustinus* looks suspiciously: Some large and old *Alaternus*'s are kill'd, especially such as were more exposed to the Sun, whereas those that grow in the Shade escape; the Reason of which I conjecture to be, from the Reciprocations of being somewhat relaxed every Day, and then made rigid and stiff again all Night, which bending and unbending so often, opening and closing the Parts, does exceedingly mortify them, and all other tender Plants, which growing in shady Places undergo but one Thaw and Change. Most of these will yet revive again at the Root, being cut close to the Ground. The *Phillyrea's Augusti*, and *Serratifolio's* (both of them incomparably the best for ornamental Hedges of any of the *Perennial Greens* I know) have hardly been sensible of the least Impression, more than tarnishing of their Leaves: no more have the *Spanish Jasmines*, and *Persian*; and I enumerate these Particulars the more minutely, that Gentlemen who are curious, may take notice what Plants they may trust to abroad, in all Events, for I speak only of such as are exposed.

I need say nothing of *Holly*, *Yew*, *Box*, *Juniper*, &c. (hardy and spontaneous to our Country) and yet to my Grief I find an *Holly* Standard of near an hundred Years old, drooping and of doubtful Aspect, and a very beautiful Hedge (tho' indeed much younger) being clip'd about *Michaelmas*, is mortified near a Foot beneath the Top, and in some Places to the very Ground; so as there's nothing seems Proof against such a *Winter*, which is late cut and expos'd. This Hedge does also grow against the South, and is very russet, whilst the contrary Side is as fresh and green as ever; and in all other Places of my Plantations that are shaded, the unshorn *Hollies* maintain their Verdure, and are I judge impregnable against all Assaults of *Weather*.

Among the *Fruit-Trees*, and *Murals*, none seem to have suffer'd save *Figs*, but they being cut down, will spring again at the Root. The *Vines* have escaped, and of the *Esculent Plants* and *Salads* most, except *Artichokes*, which are universally lost, and what I prefer before any *Salad* whatever eaten raw, when young, my *Sampire* is all rotted to the very Root: How to repair my Loss, I know not, for I could never make any of the Seed, which came from the *Rock Sampire* (tho' mine were of the very kind) to grow.

The *Arborescent* and other *Sedums*, *Aloes*, &c. (tho' hous'd) perished with me; but the *Yucca* and *Opuntia* escaped. *Tulips* many are lost, and so the *Constantinople Narcissus*, and such *Tuberose* as were not kept in the Chimney-Corner, where was continual Fire. Some *Anemonies* appear, tho' I believe many are rotted: But I have made no great Search in the flowery Parterr,

only I find that most Capillaries spring, and other humble and repent Plants, notwithstanding all this rigorous Season.

My *Tortoise* (which by his constant burying himself in the Earth at Approach of Winter, I look upon as a kind of Plant-Animal) happening to be obstructed by a Vine-Root, from mining to the Depth he was usually wont to interr, is found stark dead, after having many Years escaped the severest Winters. Of *Fish* I have lost very few, and the Nightingales (which for being a short-winged Bird, and so exceeding fat, at the time of the Year, we commonly suppose them to change the Climate: whereas indeed they are then hardly able to fly an hundred Yards) are as brisk and frolick as ever, nor do I think they alter their Summer Stations, whatever become of them all Winter.

In this rigid Season nothing seemed more surprizing to us, nor more generally known to be true, than the cleaving or *splitting* of Trees, as of the *Elms* by Mr. Langley's House the Minister of *Tamworth*, and *Asbes* of considerable Bulk and Value, designed for and capable of divers Uses, as *Will-Mill-Posts*, Dresser-Boards, and other necessary Occasions. Also *Wallnut-Trees* in divers Places have suffered by this Calamity, and proved extremely *cleft*, though indeed it hath been most frequent among *Oaks*, many of which have been divided to great Detriment in *England*, some being so rent that a Man may see through them, and that many times the Cracks came with so great Noise, that as it is related from *Needwood-Forrest*, they made such a Noise, that the Keepers there thought that the Deer were shot by the People of the Country; and that in several Parts they were heard as loud as Guns, some having been cruelly affrighted, especially in the Evenings or Nights, as they have passed within the hearing of this so unexpected and surprizing a *Noise*. Which *Rifts* or *Clefts* were not at all to the same Point of the Compass, but sometimes on one side only, sometimes two, and sometimes three, and sometimes four several Places, dividing or quartering the Tree, and sometimes quite through: And these *Clefts* were not only in the Bodies, but continued into the larger Boughs and Limbs of the Tree, and sometimes descended into the superficial Roots, but not to those very deep in the Earth: The *Frost*, though extream, not reaching considerably deep, comparatively to the *Roots* of *Trees*, and the hard binding of the Earth being so *frozen*, would not easily admit of Compressure: But several shallow *Roots*, so knotted and knurled as not to be wrought upon with Beetle and Wedges, are known to be *cleft* by the *Frost*. But it is much to be doubted and suspected whether any such *cloven* Trees were so perfectly sound and faithful Timber, if proved by the Saw and Ax, as they ought to be, for if so, all might equally suffer, the Air having impartial Access to one as well as the other; but some being taken with this Disease, and others left untouch'd, there certainly was some Cause or Defect in those liable to it, rather than the rest. A great Part of the Cause of it is supposed to be Imperfection in such a Tree, and that generally from the too large *Sap-Vessels* and unnatural Cavities therein, which some call *Wind-shaken*, and some *lagg'd* Trees; the Cause whereof remains yet to be examined, whether the *shaking* of the Wind may not, with its great Weight and

Force, taking the whole Tree with its Boughs, Limbs and Body, having one End firmly fixed in the Earth at some Age or other, as well work wrack and make Splintering and stretched Pores, Passages, Cavities, and such like, in a live and growing Tree, at sometimes of Continuance of its Force with its oft repeated beating, twisting, and pressing Blasts, as well as the best chosen Mast of a Ship may suffer Damage by the same Cause, even to total Fraction. By some this is supposed to proceed from Earthquakes, but whether or not, is yet to be examined. But the Opinion of some seems not to be extravagant, who think it to be an original Distemper in the Tree, and to proceed from the *Soil*, or rather an innate Disease from some though undiscernable Imperfection in the *Seed* it self, and yet not so much but that they live many Years, and grow to great Bulk and Stature, being observed to bear lesser Leaves and smaller Acorns; but whether the *Soil* be concerned, it may be urged, that the Trees about *Oxford* Westward, being generally affected with this Disease, and those from the East side proving excellent sound Timber, tho' the *Soils* seem to resemble one another.

But by what Means soever this may come, it is certain that some Trees are much more sound than other, and that some prove full of inbred Diseases and Cavities, before they are cut down, which Cavities and stretch'd Vessels being fill'd with too great a Quantity of aqueous and undigested *Sap*, as it were *hydropical*, (for it is thought that the genuine and natural *Sap* of these our native Trees, though undergoing Condensation, will remain secure and safe, as may be supposed from those that are well and firmly standing) are thereby rendred capable of not only Condensation but *Glaciation* also by the Continuance and Severity of the Air's *frigefactive* Power; which being sufficiently known to employ more Room being *Ice*, than formerly Liquid, might probably cause these *Breaches*, and if we consider the expansive Motion and Spring of the Air included in the Cavities of the *Air Vessel*, suffering more Pressure than they are patient of, from the *coagulated* and contiguous aqueous Parts then *congealed*, may be induced to suppose these *strepitous* Eruptions to proceed from thence. But whether Mr. *Hobbs's* Hypothesis will certainly hold, that the Swelling is caused by the Intrusion of the Air, is somewhat to be doubted.

It need not prove troublesome to any to think the *Ice* to be able to *tear* the *Oaks* or other Trees, who shall consider the great Force and elastick Power thereof; whereof that most excellent and curious Philosopher of our Age, Esquire *Boyle* hath, in his *History of Cold*, set forth several Experiments and Examples, as Vessels of several kinds of Metals being made strong on purpose, and fill'd with Water, close stopp'd and exposed to the *Cold*, which being not capable of withstanding the expansive Force of the inclosed *Ice*, having been found *cleft* and broken; as for Instance, the strong Barrel of a Gun close stopped, with Water in it and *frozen*, hath proved rent long ways, and never across the Vessel, nor Bodies of the Trees we here mention. Another time a Brass Vessel of a Cylindrical Form being made not more than five Inches deep and not two Diameter, filled with Water, and afterwards *frozen*, in one Night lifted off the Cover prepar'd and closely fitted,

fitted, with a Weight of fifty six Pounds that was laid upon it. *Olearius*, Secretary to the Duke of *Holfstein's* Embassy into *Russia*, tell us, that in the City of *Moscow* he observed, (the *Cold* being very intense) the Earth to be cleft many Yards in length, and a Foot broad, which according to Conjecture, was occasioned by the heaving and swelling thereof to enlarge its Room, as here we see Ice crackt and cleft considerably long and broad, according to its Thickness along the Ridge or turgid Part thereof. And that the Earth doth so rise when frozen is easily made manifest by little Sticks or Plants set into the Ground against the approaching Winter, which being risen two or three Inches, or more, according to the Depth and Strength of the Frost, and upon the Thaw the Earth sinking to its former Station, leaves the unfixed Plants with their Roots naked above Ground, as it were, spewed out. And not such moist Bodies only, but Metals, as Bräis, Iron, &c. having been swelled in the Time of being frozen, as hath been proved by Clocks, Locks, and other Instruments, and become lax and pliant again upon the Thaw. Many more Examples might be easily produced to induce us to the Thoughts, that the Sap is not right and genuine in such ill-disposed Trees, and that Ice might, upon due Examination, be found in any such bursten Bodies, as we are informed have been found and observed by some; and if Ice, then Pressure, and if Pressure, then Breaking and Explosion.

It may be doubted too, whether some of these Trees thus liable to the Fury of the Frost, have not been *Coltie*? A Term commonly used among *Timber-Merchants*, and by them avoided; which is, towards the middle of the Tree, among the *Annual Circles*, some one is much larger than the rest, and the *Sap-vessels* there seem much extended beyond their Fellows, and upon cleaving or sawing such a Tree, that inclosed or inward Heart, Part thereof where that Circle is, will slip and drop from the other Part oft-times without any Force to divide it, as an Instrument out of a Case or Mould made fit for it.

Some suppose that these *wind-shaken* or *lagg'd* Trees may be known or nearly guessed at by the Out-side, when growing, by the great Ribbs, two, three, or four in a Tree from the Bottom to the Branches, and that they have been affected somewhat considerably with this Disease before, and perhaps cleft, (tho' not in so great a Measure as now) and the Fissures closed up again; as we see these do quickly after the Frost, insomuch that it is scarce discernable already, and the Bark not having been divided from the Body, upon coming together again, each turn and twist of the Grain fitting its Place, prove fresh and vigorously growing: But that ever such Trees will prove whole and sound, doth scarcely consist with Reason or our present Thoughts. And this Calamity hath not been found in Trees only that were fresh and standing, but also in Trees cut down, as is affirmed by Mr. *Sbisb* and others; but notwithstanding it is thought to be only among such diseased Trees as are before-mentioned.

But it is yet to be questioned whether *Vines* have proved cleft and crackt along the Bodies by the same Way and Reason as *Timber-Trees*, which Decay is especially to be seen on Walls exposed to the Southern Aspect; so that the Sun, our accustomed Friend, now proved our great Enemy, by thawing and relaxing

relaxing the Sap every Day, and then being frozen and made stiff again every Night; which often Repetition of bending and unbending, softning and hardning, the vivid spirituous Juice being destroyed, and Day and Night the Drought vigorously acting, (the Sap being this Year disordered and surprized, not gradually seasoned even before *Michaelmas-Day*, and the fresh Sap to supply its Defects being wholly detained from arising, there then being none or very little Exhalations or Evaporations arising out of the frozen and bound Earth) these poor slender Bodies fill'd only with thin and not viscous Sap, have proved as great Sufferers as if by Amputation they had been deprived of their natural Sustenance; for if they could have none from the Earth, and their own true Juice mortified, and it be certain that *omne Siccum appetit humidum*, it will follow that such Branches will by the Constancy and Continuance of such Severity (the Day being as bad as the Night) prove as dry as Sticks cut off long before: whereas those of this kind and other sorts also growing in more shadowy Parts, and undergoing but one Change, have remained in good Condition, especially among red Grapes, which seem much more hardy than white ones.

We see other *Wall-Fruits* on the same Position, as *Apricocks*, *Peaches*, *Plumbs*, *Cherries*, &c. are not at all injured or prejudiced by the Weather, which are of a more clammy viscous Juice: These we see run sometimes and give Gum, but the Leakage of *Vines* is as thin as Water, which different Juices and Saps in other Trees, and the Degrees thereof, as well those with deciduous Leaves, as *Ever-greens*, may prove some Cause of the Weakness and Decay of some, whilst that of another sort standing by, remains fresh and vigorous, only stagnated, sedate and quiet, waiting for the benign Sun's Beams to actuate, lenify, and put its Spirits in Motion, and its comfortable Refreshment to arise in due Season: And perhaps according to the Degree of this Qualification in Trees and Plants, (some being much more sluggish than other) may be the Cause of their earlier or later *Germination*.

It is easily observed, that in dry, mountainous rocky and barren Plantations, where Trees, Greens, and other Plants, having been sparingly fed, and not pamper'd with such Luxuriance and Freeness of Sap, as in the Vallies and richer Soils have escaped tolerably well: and by this which in other Years proves their Poverty and Disease, now make them insult over those growing in the fatter Vallies, proportional to the Height of the Hills they grow on.

We may observe *Trees* all the Winter, while the Sap remains condensed, to be safe and well, but if a flattering too early Glance happens in the Spring to set their Parts in Action, and the Juices to become fluid, and a sudden Mutation of that Warmth to a fresh Return of Winter, (which too frequently happens in *England*) that then we have not only our Hopes of that Year's Fruit blasted, but even the Passages in the Branches and Boughs stopped, and the crude Sap settling, commonly called *Bliting*, (tho' there be many Causes of the Effects which go under that Notion) becomes a Disease in Trees equal to that of *Gbil-blaines* in juvenile Blood, which sometimes takes whole Trees, and sometimes Branches only. Hence is supposed the Decay of the *Glaſtenbury Thorn*, whose Arising-time being between *Michaelmas* and

Christmas,

Christmas, being happily prepared by the Beginning of the hard *Frost*, which hath almost affrighted it out of its Life.

Some Trees and Shrubs seem to have their Vessels and Passages so streightened, and as it were shrunk with *Cold*, that they appear equal to a human Body *Sinew-shrunk* or *Paralytick*, that is not without much Trouble able to move or bear his decaying Limbs: Thus we see *Trees* with their Bark shrivel'd, with their Passages half-stopt, whose *Sap* now only squeezing, and difficultly passing, hath much ado to force its Way thro' the dry'd and narrow Pores and Passages of the Body and Branches: And sometimes this Distemper is so prevalent, that whole Branches of a Tree are killed, when the other Part is indifferent well.

Some Liquids, such as *Essential Oyls*, do rather shrink than increase being frozen; and *Empyreumatical Oyls*, will hardly freeze but waste; which Considerations may induce the Thoughts of what some *Trees* are made of, or do abound in, as *Firrs*, *Pines*, &c. which are capable of enduring the *Cold* of *Norway*, and other Countries.

What *Timber-Trees* have suffered, are above specified; but divers others of our native *Trees* and *Shrubs* have scarcely proved able to withstand the Force of so rude an Enemy. *Yew* and *Holly* (things whose Tenderness was never suspected) were in some Places quite kill'd, and in many Places so discourag'd, losing their Leaves, and blemishing the Bark, that it is to be feared they will never take on their pristine Splendour and Verdure. The *Furze* in many Places quite kill'd, and in most Places cut down and spring again, but often the Resurrection in vain expected. Common *Broom* proves a Degree harder. In some Places the sunny Side of a *Juniper Bush* proves scorcht between Sun and Cold, but that proves one of the most hardy of our native *Greens*; so that it is hard to say what is Winter-proof even among our Natives, except *Box* and *Ivy*, which stand in Defiance of all.

In the Gardens (which are generally Nurseries of *Exoticks*, and from warm Countries) this Calamity hath principally bent its Force against *Winter Greens*, such as *Alaternus* (commonly known by the Name of *Phillyrea*) and the true *Phillyrea* also, which are generally kill'd; though some upon cutting down spring again. Also common *Bays* seem in most Places to be kill'd down, and *Laurel* seldom proving impatient, is in some Places kill'd, in some Places half dead; *Rosemary*, *Laurustine*, *Halimus*, *Arbutus*, white *Jessamine*, and other which seldom fail, are generally kill'd thro' the whole Country: But in all these, and other such like, in mountainous and dry Places (as was before observed) there is brisk Life and Verdure yet remaining, tho' rarely to be met with; but however enough to retain the several *Species* among us. But if for the future in such Times of Extremity, the Superficies of the Ground, and Bodies of such things here recited, and *Fig-trees* were well covered with strawy Matter to keep off the Frost, it might so preserve them as to spring out plentifully the Spring following, tho' their whole Tops being too large and high, and thereby incapable of such Covering, might lose their present Leaves and Beauty; which might from such Respringing be easily repaired, and prove much more satisfactory than to begin the World anew, as we are generally.

generally forc'd to do for *Cypresses*, which were used to be excellent Ornaments both in Summer and Winter, now it proving a very rare thing to see one well alive; in some Places there appears some lingring Life, tho' scarcely sufficient to recover the whole, but in most Places they are quite dead, that have faced forty, fifty, or sixty Winters before.

Also among those with *Deciduous Leaves*, divers have been Sufferers, as *Arbor-Judæ*, young *Plane Trees*, though those of considerable Stature have pretty well escaped, *Paliurus*, the *Aleppo Ash*, in some Places the *Locust Tree*, and in most Hedges the great common Bramble, and some other, which upon cutting, do some or most of them spring again.

But such *Greens* also as we receive from abroad, and are the Glory of warmer Countries, and very rare, curious and pleasant with us, such as *Oranges*, *Lemons*, *Myrtles*, *Pomegranates*, and the perfuming *Jasmines*, and divers other Rarities, which are usually kept in Pots and Cases, for the Convenience of removing them into *Green-Houses* and *Conservatories*, not being able to endure our milder Winters, have in many Places extreemly suffered, especially in Houses of weaker Defence: But where the Skill, Care, and due Management of their Keepers, have met with the Convenience of good warm Houses, with keeping constant Fires, (which is a Matter to be regulated with great Discretion) according to the Proportion of which combining Qualifications the Plants have escaped; as in some Places most of them are well, and in some Places half, and in some Places all dead.

Among *Plants*, *Herbs*, and *Flowers*, there hath been great Destruction also, and many of common Use, as most of the *Artichokes* in *England*, and *Winter Coleflowers*, *Sage*, *Tyme*, *Mastick*, *Lavender*, *Laven-Cotton*, and divers other were generally kill'd: Except such as happened to be new planted that Year, and so low, that they had the Enjoyment of the kind Covering of a little *Snow*, which proves the most natural Feeding and warm Covering, of any thing to be mention'd; but what peeped its Head above it seemed in great Danger of being kill'd; and as we may see in the *Corn-fields*, that those Sides of the Lands of Corn facing the South, where the *Snow* was melted, and the Corn deprived of its Covering, the Want proved deadly, and in many Places Husbandmen were forced to begin again in the Spring to plough and sow other Grain; which may easily teach us rather to heap *Snow* upon our Herbs and Flowers, than fancy it a cold, unkind Enemy.

But after all this Repetition of Sorrows, we are to comfort our selves that such Destruction and Calamity happens but very rarely, the like having not been known in the Memory of Man, if ever before, and that with due Care and Observance the growing Cold might be kept off from such things as are proved to be impatient of it; which are not all *Greens* in our Gardens; some being able to endure all the Cold that ever came, as *Firrs*, *Pines* of divers sorts, *Cedars* of *Libanus* and *Virginia*, (tho' that of *Bermudas* proves tender) *Arbor Vitæ*, all the *Savins*, whereof the upright or *Berry-bearing* is the best *Succedaneum* to *Cypress*, capable of finer cutting into *Pyramids*, or other Figures, or Hedges 6 or 8 Foot high, and is one of the best of the *Tonfile Shrubs*; also the *Pyracantha* proves exceeding hardy, and makes good Hedges.

LIV. The *Snow* and *Ice-houses* at *Livorne*, are commonly built on the side of a steep Hill, being only a deep Hole in the Ground, by which Means they easily make a Passage out from the Bottom of it, to carry away all the Water; which if it should remain stagnating therein, would melt the *Ice* and *Snow*: But they thatch it with Straw, in the Shape of a Sauce-pan Cover, that the Rain may not come at it. The Sides (supposing it dry) they line not with any thing, as is done in *St. James's Park*, by Reason of the Moistness of the Ground. This Pit they fill full of *Snow* or *Ice*, (taking Care that the *Ice* be made of the purest Water, because they put it into their Wine) overspreading first the Bottom very well with *Chaff*, but without any Part of the Straw; I think they use *Barley-chaff*. This done, they further, as they put in the *Ice* or the *Snow*, (which latter they ram down) line it thick by the Sides with such *Chaff*, and afterwards cover it well with the same; and in half a Year lying so, 'tis found not to want above an eighth Part of what it weighed when first put in. Whenever they take it out into the Air, they wrap it up in this *Chaff*, and it keeps it to Admiration.

To preserve
Ice and
Snow; by
Mr. W. Ball,
n. 2. p. 139.

LV. Among several Ways by which I have made *infrigidating* Mixtures with *Sal Armoniac*, the most simple and facile is this: Take one Pound of powder'd *Sal Armoniac*, and about three Pints, (or Pounds) of Water, put the *Salt* into the Liquor, either all together, if your Design be to produce an intense, tho' but a short *Coldness*; or at two, three, or four several Times, if you desire that the produced *Coldness* should rather last somewhat longer than be so great: Stir the Powder in the Liquor with a Stick or Whalebone (or some other thing that will not be injured by the fretting Brine that will be made) to hasten the Dissolution of the *Salt*; upon the Quickness of which depends very much the Intensity of the *Cold* that will ensue upon this Experiment.

Cold produced
with *Sal Ar-*
moniac; by
Mr. R. Boyle,
n. 15. p. 255.

That a considerable Degree of *Cold* is really produced by this Operation, is very evident: *First*, to the Touch; *Secondly*, by this, that if you make the Experiment (as for this Reason I sometimes chuse to do) in a Glass Body, or a Tankard, you may observe, that whilst the Solution of the *Salt* is making, the Outside of the metalline Vessel will, as high as the Mixture reaches within, be bedewed (if I may so speak) with a Multitude of little Drops of Water, as it happens when Mixtures of *Snow* and *Salt*, being put into Glasses or other Vessels, the aqueous Vapours that swim to and fro in the Air, and chance to glide along the Sides of the Vessels, are by the *Coldness* thereof condensed into Water. But, *Thirdly*, the best and surest Way of finding out the *Coldness* of our Mixture, is by plunging into it a good seal'd *Weather-glass* furnish'd with tinted Spirit of Wine. For, the Ball of this being put into our *frigorifick* Mixture, the crimson Liquor will nimbly enough descend much lower, than when it was kept either in the open Air, or in common Water, of the same Temper with that wherein the *Sal Armoniac* was put to dissolve. And if you remove the Glass out of our Mixture into common Water, the tinted Spirit will re-ascend; and this has also succeeded

with me when I removed it into Water newly impregnated with *Salt Petre*.

This *Cold* in Summer and hot Weather will soon decay and expire: But if the Quantity of the *Salt* and *Water* be great, the Effect will be as well more lasting as more considerable. I have Reason too to suspect, that there may be a considerable Disparity as to their Fitness to produce *Cold* betwixt several Parcels of *Salt* that are without Scruple look'd upon as *Sal Armoniac*. I have also often found, that when the tincted Liquor subsided but slowly, or was at a Stand, by putting in from time to time two or three Spoonfuls of fresh *Salt*, and stirring the Water to quicken the Dissolution, the *Spirit* of *Wine* would begin again to descend, if it were by a Stand or Rising, or subside much more swiftly that it did before. And if you would lengthen the Experiment, it may not be amiss that Part of the *Sal Armoniac* be but grossly beaten, that it may be the longer in dissolving, and consequently in cooling the Water. After this Manner a sensible, adventitious *Cold* has been made in the Spring, by a Pound of *Sal Armoniac* at the utmost to last about two or three Hours.

Experiments in March 27. The tincted Spirit in the seal'd *Weather-Glass*, when first put into the Water, rested $8\frac{1}{2}$ Inches: Being suffered to stay there a good while, and now and then stirr'd to and fro in the Water, it descended at length a little beneath $7\frac{1}{2}$ Inches. Then the *Sal Armoniac* being put in, within about a Quarter of an Hour or a little more it descended to $2\frac{1}{2}$ Inches, but before that Time, in half a Quarter of an Hour it began manifestly to freeze the Vapours and Drops of Water on the Outside of the Glass. And when the *frigorifick* Power was arrived at the Height, I several Times found that Water thinly placed on the Outside, whilst the Mixture within was nimbly stirr'd up and down, would freeze in a Quarter of a Minute, by a Minute Watch. At about $\frac{3}{4}$ of an Hour after the *infrigidating* Body was put in the *Thermoscope*, that had been taken out a while before, and yet was risen but to the lowest freezing Mark, being again put in, the Liquor fell an Inch beneath the Mark. And about $2\frac{1}{2}$ Hours from the first Solution of the *Salt*, I found the tincted Liquor to be in the midst between the freezing Marks, whereof the one was at $5\frac{1}{2}$ Inches (at which Height when the Tincture rested, it would usually be, some, tho' but a small, *Frost* abroad) and the other at $4\frac{1}{2}$ Inches; which was the Height, to which strong and durable *Frost* had reduced the Liquor in the Winter. At three Hours after the Beginning of the Observation, I found not the crimson Liquor higher than the upper freezing Mark newly mentioned; after which it continued to rise very slowly for about an Hour longer; beyond which time I had not Occasion to observe it.

2. This *frigorifick* Mixture having been made in a Glass-Body, (as they call it) with a large and flattish Bottom, a Quantity of Water, which I (purposely) spilt upon the Table, was by the Operation of the Mixture within the Glass, made to freeze, and that strongly enough, the Bottom of the Cucurbit to the Table; that stagnant Liquor being turned into solid Ice, that continued a considerable while unthaw'd away, and was in some Places about the Thickness of a Half-Crown Piece.

3. At

3. At another Time the same Spring the *Weather-Glass*, which before it touched the common Water, stood at $8\frac{1}{4}$, having been left there a considerable while, and once or twice agitated in the Water, the tinted Liquor sunk but to $7\frac{1}{4}$, or at farthest to $7\frac{1}{2}$, then the *frigorifick* Liquor being put into the Water, with Circumstances disadvantageous enough, in (about) half a Quarter of an Hour the tinted Liquor fell beneath $3\frac{1}{4}$; and the *Thermoscope* being taken out, and then put in again, an Hour after the Water had been first *infrigidated*, subsided beneath five Inches, and consequently within $\frac{1}{4}$ of an Inch of a Mark of the strongly freezing Weather.

The grand thing that is like to keep this Experiment from being generally useful, is the Dearness of *Sal Armoniac*. But to lessen this Inconvenience, two Things may be offer'd; First, That *Sal Armoniac* might be made much cheaper, if instead of fetching it beyond Sea, our Country-men made it here at home. Secondly, That tho' an *Armoniac* Solution being boyl'd up in Earthen Vessels (for Glass ones are too chargeable) will, by piercing them, both lose some of the more subtile Parts, and thereby somewhat impair the Texture of the rest; yet I was not deceived in expecting, that the dry Salt, remaining in the Pipkins, being re-dissolved in a due Proportion of Water, would very considerably infrigidate it; as may farther appear by the following Experiment.

4. *March 29.* The *Thermoscope* in the *Air* was at $8\frac{1}{4}$ Inches; being put into a somewhat large evaporating Glass, fill'd with Water, it fell after it stay'd a pretty while, and had been agitated in the Liquor, to eight Inches: then about half the Salt, or less, that had been used twice before, and felt much less cold than the Water, being put in and stirr'd about, the tinted Spirit subsided with a visible Progress, till it had fallen manifestly beneath four Inches; and then having caused some Water to be freshly pump'd and brought in, though the newly-mentioned Solution were mixt with it, yet it presently made the Spirit of Wine manifestly to ascend in the Instrument, much faster than one would have expected.

The Length of the Cylindrical Pipe of the seal'd *Thermoscope*, wherewith these Observations were made was sixteen Inches; the Ball about the Bigness of a somewhat large Walnut, and the Cavity of the Pipe, by Guess, about an eighth or ninth Part of an Inch Diameter.

To cool Drinks with this Mixture, you may put them in thin Glasses, the thinner the better; which (their Orifices being stopp'd, and still kept above the Mixture) may be moved to and fro in it, and then be immediately poured out to be drunk. By the Help hereof, Pieces of Crystal, or Bullets, for the cooling of the Mouth or Hands of those Patients, to whom it may be allowed, may be potently cooled; and other such Refreshments may be easily procured. In which, and many other Uses, it will not be requisite to employ near so much as a whole Pound of *Sal Armoniac* at a time. For, you may easily observe by a seal'd *Weather-Glass*, that a very few Ounces, well powder'd and nimbly dissolv'd in about four times the Weight of Water, will serve well enough for many Purposes.

Experiments
about Freez-
ing; by S.
Carolo Ri-
naldini, n.
72. p. 2169.

LVI. 1. A little Water being left at the Top of the *Mercury* in the *Toricellian* Experiment, and exposed to the Air in frosty Weather, was in one Night congealed into *Ice* of a very good Consistence. Afterwards, *Rinaldini* having compared this *Ice* with that which was produced in the open Air, found, that the *Ice* in the Cane was in Substance altogether like that of *Hail*; that is, an opaque and whitish Body: Whereas that which was made in the Air was transparent like Crystal. Besides, he observed that the *Ice* made in the Cane was heavier in *Specie* than that in the ambient Air, which he discover'd by putting it into a Fluid, which was in *Specie* lighter than Water, but heavier than *Ice* made in the open Air; whereby he found, that whereas the *Ice* made in the Cane sunk, that in the Air floated therein.

By Dr. Li-
ster. n. 167.
p. 835.

2. December 3, 1684. At Night I expos'd four Glass-Bottles in the open Air upon the Ground to freeze; viz. of the *Red Natron-Water* from *Egypt*; of a strong Solution of *Nitrum Murarium* in fair Water, of *Sea-Water* taken up at *Scarborough*, and more than half evaporated; of the *Sulphur Well* at at *Knasborough*, that is, of *Natural Brine* evaporated to the same Height with the *Sea Water*.

The fourth in the Morning, the Solution of *Nitrum Murarium* was half of it *Ice*, but not any of the rest.

The sixth in the Morning, the Bottle of *Nitrum Murarium* was most *Ice*; the *Sulphur-Water* had no *Ice* that I could perceive at all in it; the *Natron* had much *Ice* at the Bottom of the Bottle; and the *Scarborough Sea-Water* was not without Flakes of *Ice*.

Fig. 21, 22. The *Ice*icles of the *Natron* were prettily figured, as is represented in Fig. 21. The *Ice*icles of the *Sea-Water* were also figured in oblong Squares, as in Fig. 22, and were brittle and transparent. I set the drained *Ice*icles of *Natron* before the Fire, which did readily enough melt and dissolve into Water again; this *Ice* was both alike salt in *Ice* and in *Water*, much like the Water, to the Taste, out of which it was frozen. In like manner having drained the *Sea-Water Ice*, and expos'd it before the Fire, these *Ice*icles became soft and moist by Degrees, but at length rather evaporated than quite melted away; and having taken up a good thick Lump of common *Ice*, at least an hundred times their Thickness and Bulk, this in a few Moments at the same Distance before the Fire, grew wetter and wetter, and dissolved into Water, whereas the *Salt Ice*icles after three Quarters of an Hour lying before the Fire, did at length dry into a white Powder perfect salt, the Moisture totally evaporating. Also the *Sea-Water Ice*icles tasted very salt, when first taken out of the Water.

I repeated the same Experiment of exposing to freeze the Bottles of *Natural Brine* of *Knasborough Sulphur-Well*, half evaporated, and *Scarborough Sea Water*, the same as formerly, the seventh and eighth Instant at Night, and with the like Success, viz. no *Ice*icles in the *Natural Brine*; but the same large ones as above described I had in the *Sea Water*, but not till after the second Night's keen Freezing.

These *salt Ice*icles continued unthawed in the Bottles, though they were brought into the House, and kept in a warm Room, long after all other *Ice* within

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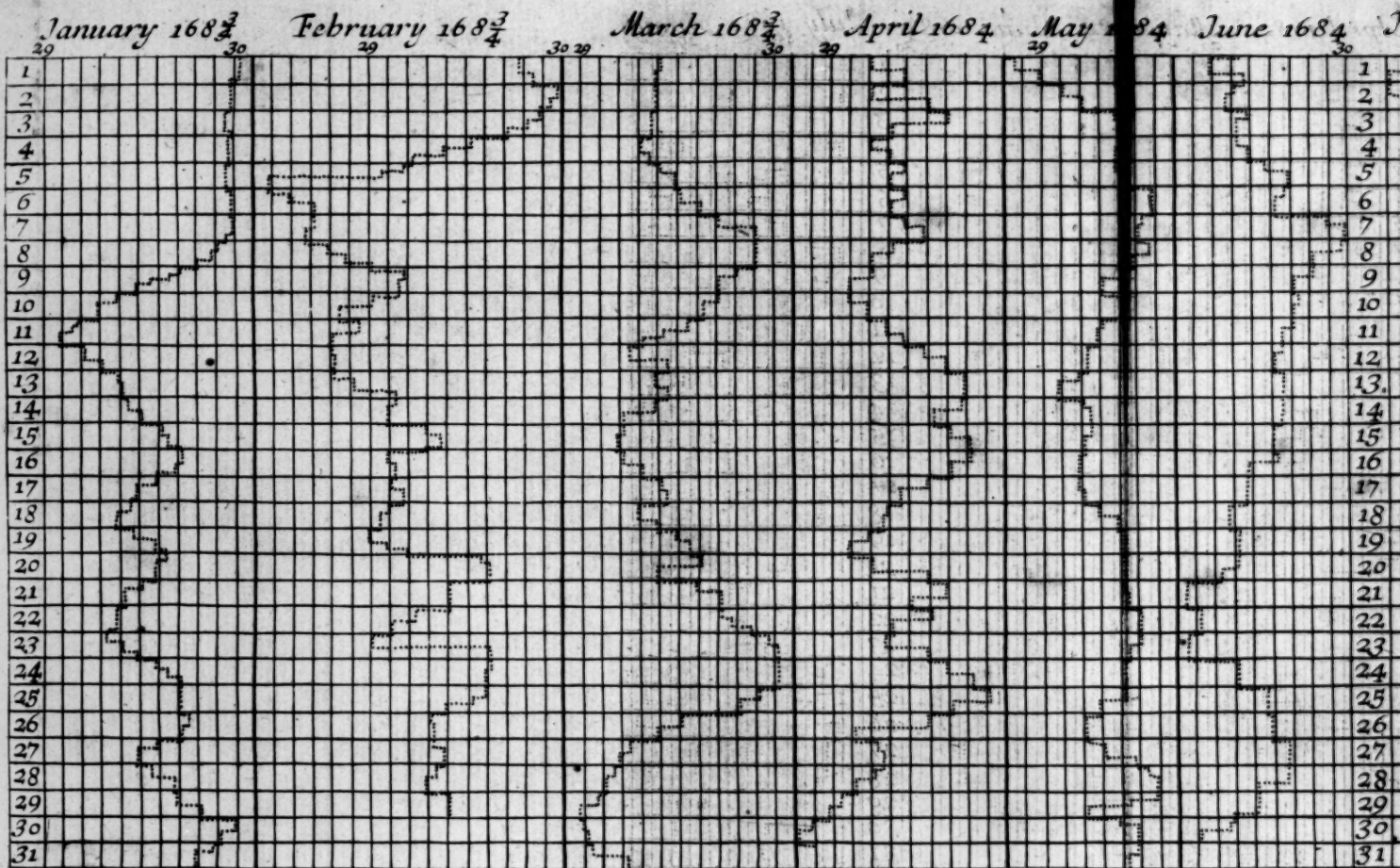


Fig. 1

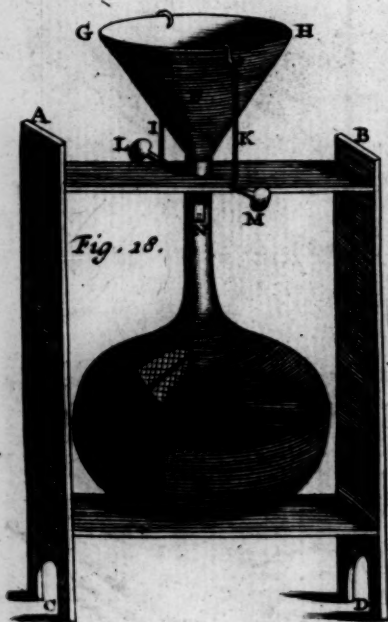


Fig. 21.



Fig. 22.



84 July 1684 August 1684 September 1684 October 1684 November 1684 December 1684

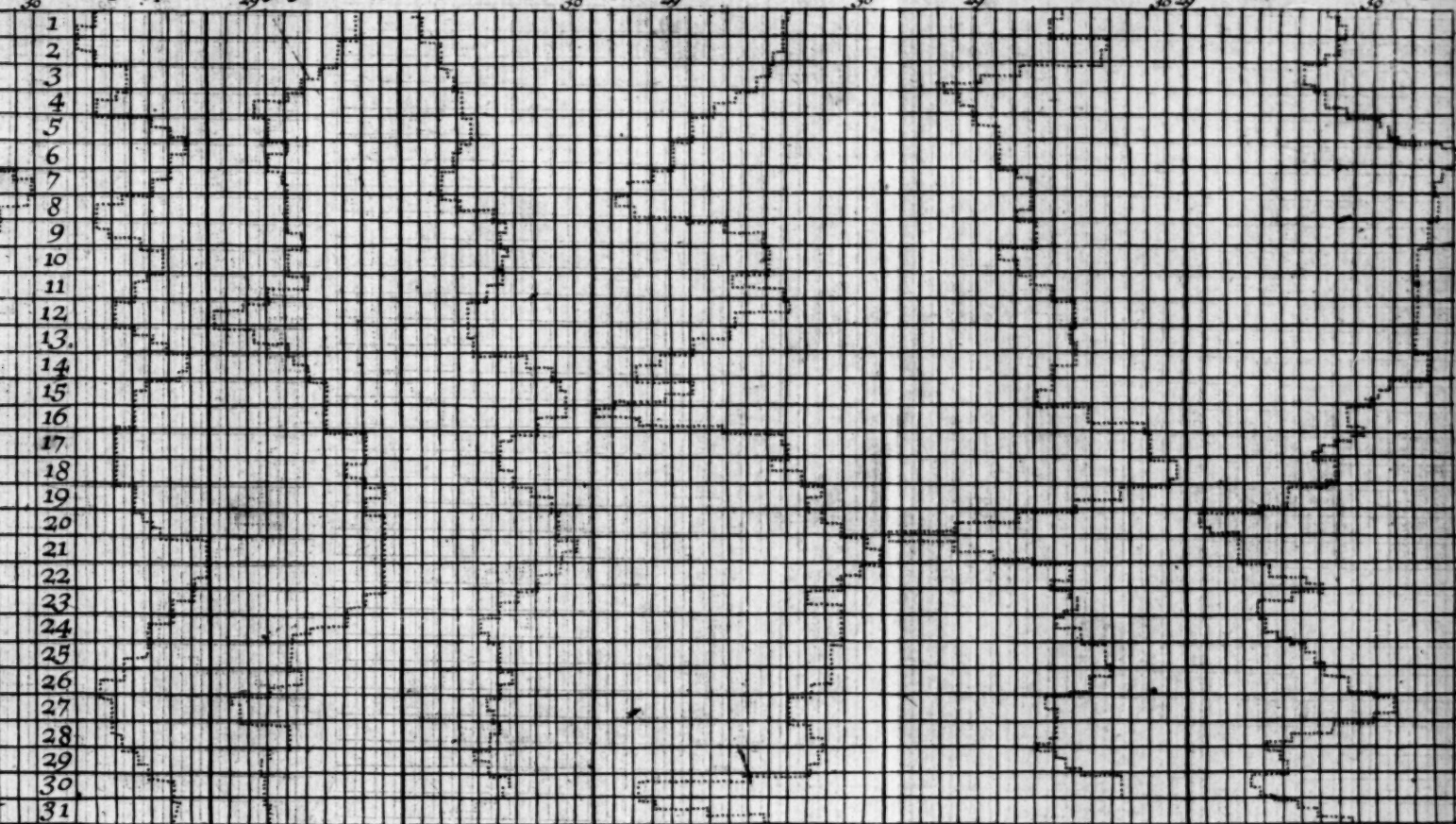


Fig. 17.

Plate 2. Vol. 2. Pag. 164.

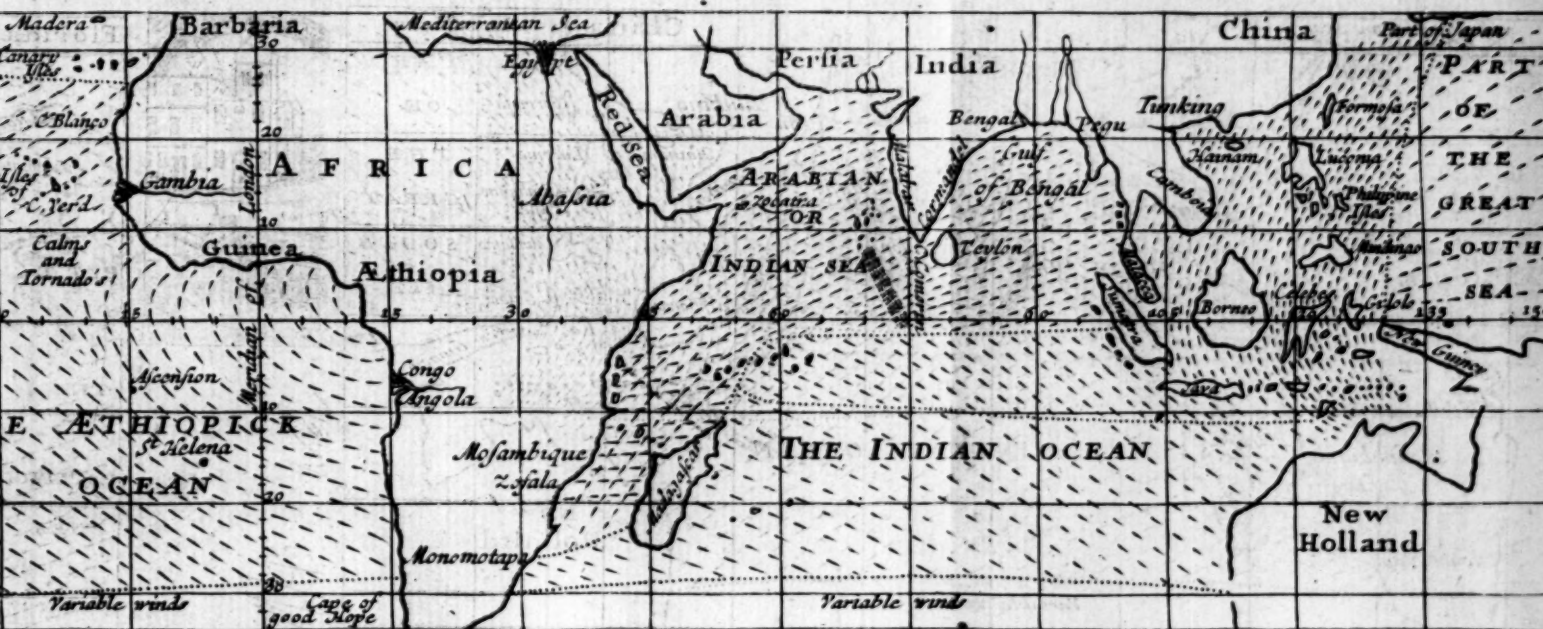
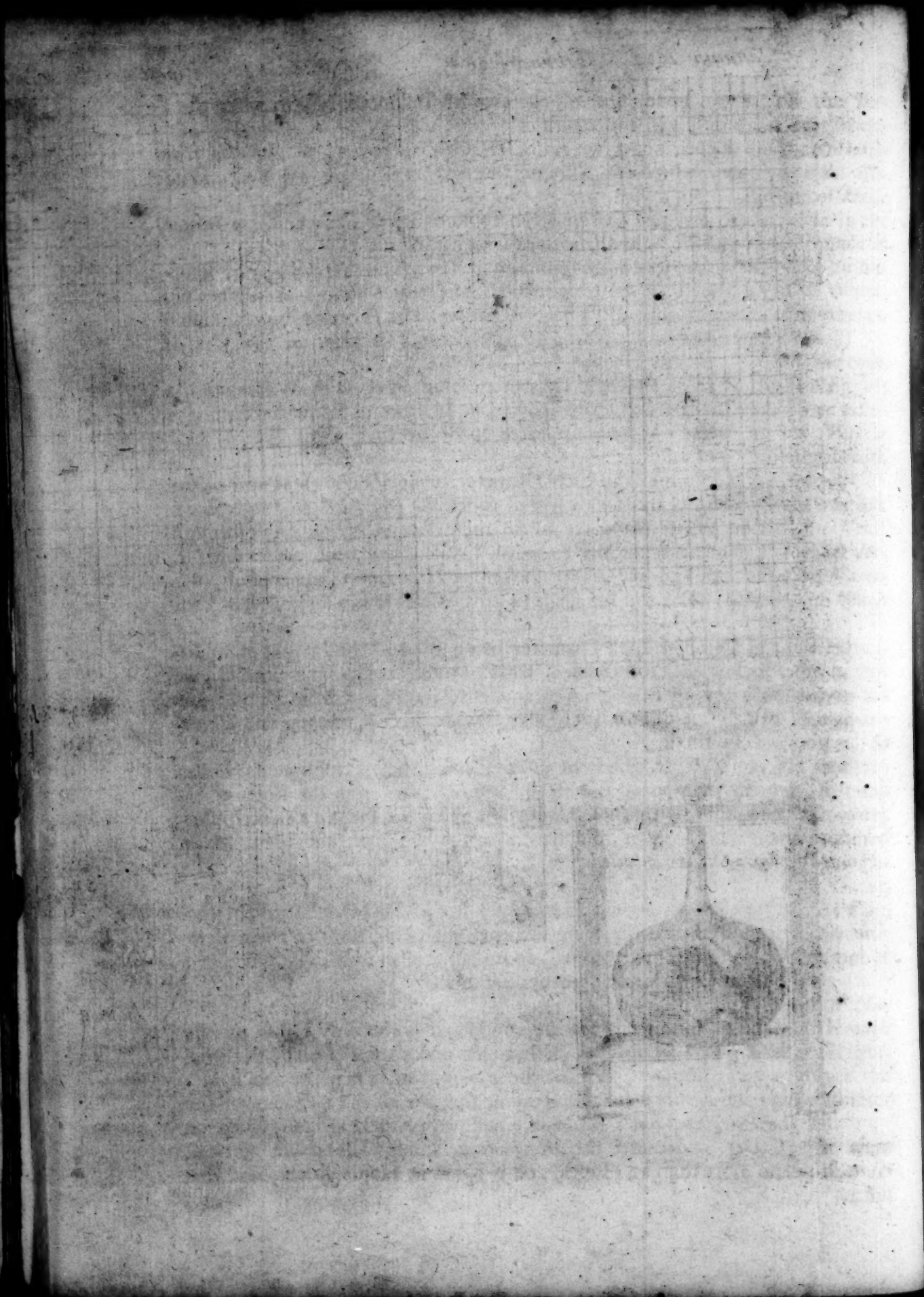


Fig. 20.



within Doors was gone, viz. till the twelfth Instant at Night, when the *Acicles* also were dissolved and vanish'd.

From these Experiments we note, 1. That there may be *Salt-Ice* from *Sea Water* frozen, which the Experiments of this S. of the last Year did not seem to favour.

2. That there is as real Difference betwixt *Natural Brine* and *Sea Water*, as there is betwixt the Salts themselves which they yield.

3. That the great floating Mountains of Ice in the *Northern Seas* (if upon strict Tryal they shall be found to be Salt, which should be further enquired into,) are not only the Effects of many Years Freezing, but also much of their Magnitude may be owing to the natural Duration of that sort of Ice.

3. A Tube of $\frac{1}{4}$ of an Inch Diameter being filled with Water, to the Height of two Inches, and set to freeze in a Mixture of Snow and Salt, the Water, when perfectly frozen, appeared $\frac{1}{8}$ of an Inch above the Mark it stood at before freezing.

By M. Des
Masters. n.
245. p. 384.
n. 247.
p. 439.

Another Tube, of almost an Inch Diameter, being fill'd with Water to the Height of six Inches, and set to freeze as before, rose $\frac{1}{4}$ of an Inch above the Mark. The Water made use of in these Tryals, was a sort of rough *Pump-Water*; which, according to what Tryals have been made with it, does, upon the Effusion of *Oil of Tartar per Deliquium*, immediately turn milky and turbid. And the Ice made of this Water was a sort of very rarified white Ice.

The Tube of almost an Inch Diameter being fill'd to the Height of six Inches (as before) with *River Water*, which would readily mix with *Oil of Tartar* without the least Precipitation, and set to freeze in a Mixture of Snow and Salt, it gained but $\frac{1}{8}$ of an Inch after it was frozen; whereas the *Pump-Water* got $\frac{1}{4}$ of an Inch.

It was observable, that when the *Water* (in all these Experiments) began to freeze, a great many small Bubbles continually rose from the Bottom.

A Tube being fill'd with *Boiled Pump-Water* to the Height of six Inches, and set to freeze as before, it rose hardly to $\frac{1}{8}$ of an Inch above the Mark, when as the same Water unboiled rose to $\frac{1}{4}$.

LVII. In July, 1653, It was so furiously hot in *Poland*, that in the Regiment of Foot which was the King's Guard, marching most of them Bare-foot upon Sands, more than 100 fell down altogether disabled, whereof a Dozen died outright, without any other Sickness.

Excessive
Heats in Po-
land; by M.
Behre. n. 19.
p. 352.

LVIII. If the Action of the Sun be considered as the only Cause of the Heat of the Weather, I see no Reason but that under the Pole, the Solstitial Day ought to be as hot as it is under the *Equinoctial*, when the Sun comes vertical, or over the *Zenith*; for this Reason, that for all the 24 Hours of the Day under the Pole, the Sun's Beams are inclined to the Horizon, with an Angle of $23\frac{1}{2}$ Deg. and under the *Equinoctial*, though he come vertical, yet he shines no more than 12 Hours, and is again 12 Hours absent, and that for

The proportion-
al Heat of
the Sun in all
Latitudes;
by Mr. Edm.
Halley. n.
203. p. 278.

for 3 Hours 8 Minutes of that 12 Hours he is not so much elevated as under the *Pole*; so that he is not 9 of the whole 24 higher than 'tis there, and is 15 Hours lower. Now the simple Action of the *Sun* is, as all other Impulses or Stroaks, more or less forceable, according to the *Sines* of the *Angle of Incidence*, or to the Perpendicular let fall on the Plain; whence the *vertical Ray* (being that of the greatest *Heat*) being put *Radius*, the Force of the *Sun* on the horizontal Surface of the Earth will be to that, as the *Sines* of the *Sun's* Altitude at any other time. This being allowed for true, it will then follow, that the Time of the Continuance of the *Sun's* shining being taken for a *Basis*, and the *Sines* of the *Sun's* Altitudes erected thereon as Perpendiculars, and a Curve drawn through the Extremities of those Perpendiculars, the Area comprehended shall be proportionate to the Collection of the *Heat* of all the Beams of the *Sun* in that space of Time. Hence it will follow, that under the *Pole* the Collection of all the *Heat* of a *Tropical Day*, is proportionate to a *Rectangle* of the *Sine* of $23\frac{1}{2}$ gr. into 24 Hours, or the Circumference of a Circle; that is. the *Sine* of $23\frac{1}{2}$ gr. being nearly $\frac{4}{5}$ of *Radius*, as $\frac{3}{5}$ into 12 Hours. Or the *Polar Heat* is equal to that of the *Sun* continuing 12 Hours above the Horizon, at 53 gr. Height, than which the *Sun* is not 5 Hours more elevated under the *Equinoctial*.

Fig. 23.

But that this Matter may be the better understood, I have exemplified it by a Scheme, wherein the *Area ZGHH*, is equal to the *Area* of all the *Sines* of the *Sun's* Altitude under the *Equinoctial* erected on the respective Hours from *Sun-rise* to the *Zenith*, and the *Area* $\odot HH \odot$ is in the same Proportion to the Heat for the same six Hours under the *Pole* on the *Tropical Day*, and $\odot HH \odot$, is proportional to the collected Heat of twelve Hours, or half a Day, under the *Pole*; which Space $\odot HH \odot$ is visibly greater than the other *Area HZGH*, by as much as the *Area HGQ* is greater than the *Area ZGQ*; which, that it is so, is visible to Sight, by the great Excess, and so much in Proportion does the Heat of the twenty four Hours *Sunshine* under the *Pole*, exceed that of the twelve Hours under the *Equinoctial*: Whence, *ceteris paribus*, it is reasonable to conclude, that were the *Sun* perpetually under the *Tropick*, the *Pole* would be at least as warm, as it is now under the *Line* it self.

But whereas the Nature of *Heat* is, to remain in the Subject after the Cause that heated is removed, and particularly in the Air, under the *Equinoctial*, the 12 Hours Absence of the *Sun* does very little still the Motion impress'd by the past Action of his Rays wherein *Heat* consists, before he arise again: But under the *Pole*, the long Absence of the *Sun* for six Months, wherein the Extremity of *Cold* does obtain, has so chill'd the Air, that it is as it were frozen, and cannot, before the *Sun* has got far towards it, be any way sensible of its Presence, his Beams being obstructed by the thick Clouds, and perpetual Fogs and Mists, and by that *Atmosphere of Cold*, as the late Honourable Mr. Boyle was pleased to term it, proceeding from the everlasting *Ice*, which in immense Quantities does chill the neighbouring Air, and which the too soon Retreat of the *Sun* leaves *unthawed*, to encrease again during the long Winter that follows this short Interval of Summer.

But

But the differing Degrees of *Heat* and *Cold* in differing Places, depend in a great Measure upon the Accidents of the Neighbourhood of high Mountains, whose Height exceedingly chills the Air brought by the Winds over them; and of the Nature of the Soil, which variously retains the *Heat*, and particularly the Sandy, which in *Africa*, *Arabia*, and generally where such *sandy Desarts* are found, do make the *Heat* of the Summer incredible to those that have not felt it.

In Prosecution of this Thought I have solved this *Problem* generally, viz. To give the proportional Degree of *Heat*, or the Sum of all the Sines of the Sun's Altitude, while he is above the Horizon in any oblique Sphere, by reducing it to the finding of the Curve Surface of a *Cylindrick Hoof*; or of a given Part thereof.

Now this *Problem* is not of that Difficulty as appears at first Sight; for let the *Cylinder ABCD* be cut obliquely with the *Ellipse BKDI*, and by the Center thereof *H*, describe the Circle *IKLM*; I say the Curve Surface *IKLB* is equal to the Rectangle of *IK* and *BL*, or of *HK* and 2 *BL*, or *BC*: And if there be supposed another Circle, as *NOPQ*, cutting the said *Ellipse* in the Points *P*, *Q*; draw *PS*, *QR*, parallel to the *Cylinders* Axe, till they meet with the aforesaid Circle *IKLM* in the Points *R*, *S*, and draw the Lines *RTS*, *QVP*, bisected in *T*, and *V*. I say again, that the Curve Surface *RMSQDP* is equal to the Rectangle of *BL*, or *MD*, and *RS*, or of 2 *BL* or *AD* and *ST* or *VP*; and the Curve Surface *QNP* is equal to *RS* $\times$ *MD* — the Arch *RMS* $\times$ *SP*, or the Arch *MS* $\times$ 2 *SP*: or, it is equal to the Surface *RMSQDP*, subtracting the Surface *RMSQNP*. So likewise the Curve Surface *QBP* is equal to the Sum of the Surface *RMSQDP*, or *RS* $\times$ *MD*, and of the Surface *RLS* $\times$ *OP*, or the Arch *LS* $\times$ 2 *SP*.

Fig. 24.

This is most easily demonstrated from the Consideration, That the *Cylindrick* Surface *IKLB* is to the inscribed *Spherical* Surface *IKLE*, either in the whole or in its analogous Parts, as the Tangent *BL* is to the Arch *EL*; and from the Demonstrations of *Archimedes*, de *Sphæra & Cylindro*, Lib. 1. Prop. 30, 37, and 38; and Doctor *Barrow's* learned Lectures on that Book, Probl. 9, and the Corollaries thereof.

Now to reduce our Case of the Sum of all the Sines of the Sun's Altitude in a given Declination and Latitude to the aforesaid *Problem*, let us consider the *Analemma* projected on the Plan of the Meridian; *Z* the Zenith, *P* the Pole, *HH* the Horizon, *ææ* the *Equinoctial*, *ssvv* the two *Tropicks*, *⊙* *I* the Sine of the Meridian Altitude in *⊙*; and equal thereto, but perpendicular to the *Tropick*, erect *⊙* 1, and draw the Line *T* 1. intersecting the Horizon in *T*, and the Hour Circle of 6 in the Point 4, and 6, 4 shall be equal to 6 *R*, or to the Sine of the Altitude at 6: And the like for any other Point in the *Tropick*, erecting a Perpendicular thereat, terminated by the Line *T* 1. Through the Point 4, draw the Line 4 5 7, parallel to the *Tropick*, and representing a Circle equal thereto; then shall the *Tropick* *ss* in Fig. 25, answer to the Circle *NOPQ* in Fig. 24. The Circle 4 5 7 shall answer the Circle *IKLM*, *T* 4 *i* shall answer to the *Elliptick* Segment *QIBKP*, 6 *R* or 6 4 shall answer to *SP*, and 5 1 to *BL*, and the Arch *⊙* *T* to the Arch *LS*, being

Fig. 25.

LS, being the Semidiurnal Arch in that Latitude and Declination; the Sine whereof, though not expressible in *Fig. 25*, must be conceived as analogous to the Line *TS* or *VP* in *Fig. 24*.

The Relation between these two Figures being well understood, it will follow from what precedes, That the Sum of the Sines of the Meridian Altitudes of the Sun in the two *Tropicks*, (and the like for any two opposite Parallels) being multiplied by the Sine of the Semidiurnal Arch, will give an Area analogous to the Curve Surface *RMSQDP*; and thereto adding in Summer, or subtracting in Winter, the Product of the Length of the Semidiurnal Arch, (taking according to *Van Ceulen's Numbers*) into the Difference of the above-said Sines of the Meridian Altitude: The Sum in one Case, and Difference in the other, shall be as the Aggregate of all the *Sines* of the Sun's Altitude during his Appearance above the *Horizon*; and consequently of all his *Heat* or *Action* on the Plain of the *Horizon* in the proposed Day; and this may also be extended to the Parts of the same Day; for if the aforesaid Sum of the *Sines* of the Meridian Altitudes be multiplied by half the Sum of the *Sines* of the Sun's horary Distance from Noon, when the times are before and after Noon; or by half their Difference, when both are on the same Side of the Meridian; and thereto in Summer, and therefrom in Winter, be added or subtracted, the Product of half the Arch answerable to the proposed Interval of time, into the Difference of the *Sines* of Meridian Altitudes, the Sum in one Case, and Difference in the other, shall be proportional to all the *Action* of the Sun during that Space of Time.

I foresee it will be objected, that I take the *Radius* of my Circle on which I erect my Perpendiculars always the same, whereas the Parallels of *Declination* are unequal; but to this I answer, that our said Circular *Basis* ought not to be analogous to the Parallels, but to the Times of Revolution, which are equal in all of them.

It may perhaps be useful to give an Example of the Computation of this Rule, which may seem difficult to some. Let the *Solstitial Heat*, in $\odot$ and ω , be required at *London*, *Lat.* $51, 32$.

$38^{\circ}-28'$ <i>Co. Lat.</i>	<i>Diff. Ascen.</i> ——— $33^{\circ}-11'$
$23-30$ <i>Decl. $\odot$</i>	<i>Arc. Semidi. Aestiv.</i> $123-11$.
$61-58$ <i>Sinus</i> = 0,882674	<i>Arc. Semidiur. Hyb.</i> $56-49$. <i>Sin.</i> 0,836923
$14-58$ <i>Sinus</i> = 0,258257	<i>Arc. Aestiv. mensura.</i> 2,149955.
<i>Summa</i> 1,140931	<i>Arc. Hyber. mensura.</i> 0,991683.
<i>Diff.</i> 0,624417	

Then 1,140931 in 0,836923 $\div$ 0,624417 in 2,149955 = 2,29734.

And 1,140931 in 0,836929 $-$ 0,624417 in 0,991638 = 0,33895.

So that 2,29734 will be as the *Tropical Summer's Day's Heat*, and 0,33895 as the *Action* of the Sun in the Day of the Winter *Solstice*.

After this manner I computed the following Table, for every tenth *deg.* of *Latitude* to the *Equinoctial* and *Tropical Sun*, by which an Estimate may be made of the intermediate *Degrees*.

Lat.

Lat.	Sun in $\gamma \approx$	Sun in ∞	Sun in ν
0	20000	18341	18341
10	19696	20290	15834
20	18794	21737	13166
30	17321	22651	10124
40	15321	23048	6944
50	12855	22991	3798
60	10000	22773	1075
70	6840	23543	000
80	3473	24673	000
90	0000	25055	000

From this Rule there follow several *Corollaries* worth Note: As, 1. That the *Æquinoctial Heat*, when the Sun comes vertical, is as twice the Square of *Radius*, which may be proposed as a Standard to compare with in all other Cases. 2. That under the *Æquinoctial*, the Heat is as the Sine of the Sun's Declination. 3. That in the *Frigid Zones*, when the Sun sets not, the Heat is as the Circumference of a Circle into the Sine of the Altitude at 6. And consequently that in the same *Latitude* these *Aggregates of Warmth* are as the *Sines* of the Sun's Declinations; and in the same Declination of the Sun, they are as the *Sines* of the *Latitudes*; and generally they are as the *Sines* of the *Latitudes* into the *Sines* of Declination. 4. That the *Æquinoctial Day's Heat* is every where as the *Co-sine* of the *Latitude*. 5. In all Places where the Sun sets, the Difference between the Summer and Winter *Heats*, when the Declinations are contrary, is equal to a Circle into the *Sine* of the Altitude at 6, in the Summer Parallel, and consequently those Differences are as the *Sines* of *Latitude* into or multiplied by the *Sines* of Declination. 6. From the Table I have added it appears, that the *Tropical Sun* under the *Æquinoctial* has of all others the least Force. And under the *Pole* it is greater than any other Day's Heat whatsoever, being to that of the *Æquinoctial*, as 5 to 4.

From the Table and these *Corollaries* may a general Idea be conceived of the Sum of all the Actions of the Sun in the whole Year, and that Part of the Heat that arises simply from the Presence of the Sun, be brought to a Geometrical Certainty: And if the like could be performed for Cold, which is something else than the bare Absence of the Sun, (as appears by many Instances) we might hope to bring what relates to this Part of *Meteorology* to a perfect Theory.

LIX. 1. May 10, 1666. About five of the Clock in the Afternoon, the Thunder (which I had heard before at some Distance) coming nearer to us, it began to Rain, and soon after (the Rain withal increasing) the Thunder

Vol. II.

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grew

Vid. D. Wallis, de Calculo Centri Gravitatis, Prop. 13. Cap. 5.

Accidents by Thunder and Lightning at Oxford; by Dr. Wallis, n. 13. p. 222.

grew very loud and frequent, and with long rattling *Claps* (tho' not altogether so great, as I have sometimes heard :) And the *Lightning* with *Flashes* very bright (notwithstanding the clear Day-light) and very frequent, when at the fastest, scarce a full Minute between one *Flash* and another; many times not so much, but a second *Flash* before the *Thunder* of the former was heard :) The *Thunder* for the most Part began to be heard about eight or ten second-Minutes after the *Flash*; as I observed for a great Part of the Time by my Minute-watch; but once or twice I observed it to follow (in a Manner) immediately upon it, as it were, in the same Moment; and the *Lightning* extream Red and fiery; so that had it been by Night as it was by Day, it would have been very terrible. And though I kept within Doors, yet I sensibly discover'd a stinking *Sulphurous* Smell in the Air. About seven of the Clock it ended, before which Time I had News brought me of a sad Accident upon the Water at *Medley*, about a Mile or somewhat more distant from hence. Two Scholars of *Wadham-College* being alone in a Boat (without a Waterman) having newly thrust off from Shore at *Medley*, to come homewards, standing near the Head of the Boat, were presently with a Stroak of *Thunder* or *Lightning*, both struck off out of the Boat into the Water, the one of them stark dead, in whom, though presently taken out of the Water (having been by relation, scarce a Minute in it) there was not discerned any Appearance of Life, Sense, or Motion: The other was stuck fast in the Mud with his Feet downwards, and his upper Parts above Water) like a Post, not able to help himself out; but, besides a present Stonying or Numbness, had no other Hurt; but was for the present so disturbed in his Senses, as that he knew not how he came there out of the Boat, nor could remember either *Thundring* or *Lightning* that did effect it. And was very feeble and faint upon it; which (though presently put into a warm Bed) he had not thoroughly recovered by the next Night, and whether since he have or no, I know not.

Others in another Boat, about ten or twenty Yards from these, (as by their Description I estimate) felt a Disturbance and Shaking in their Boat, and one of them had his Chair struck from under him, and thrown upon him, but had no Hurt. Those immediately made up to the others, and some (leaping into the Water to them,) presently drew them either into the Boat or on Shore; yet none of them saw these two fall into the Water (not looking that Way) but heard one of them cry out for Help presently upon the Stroke, and smelt a very strange stinking Smell in the Air, such as is perceived upon the striking of *Flints* together.

He that was dead, was the next Morning brought to Town; and Dr. *Willis*, Dr. *Millington*, Dr. *Lower*, and my self, with some others, went to view the Corps, where we found no *Wound* at all in Skin, the Face and Neck swart and black, but not more than might be ordinary by the settling of the Blood: On the Right-side of the Neck was a little blackish Spot about an Inch long, and about a Quarter of an Inch broad at the broadest, and was as if it had been *sear'd* with a hot Iron; and, as I remember, one somewhat bigger on the Left-side of the Neck below the Ear. Straight down the Breast, but towards the Left-side of it, was a large Place, about
three

three Quarters of a Foot in Length, and about two Inches in Breadth, in some Places more, in some less, which was *burnt* and hard, like Leather burnt with the Fire, of a deep blackish red Colour, not much unlike the scorched Skin of a roasted Pig: And on the Fore-part of the Left Shoulder such another Spot about as big as a Shilling; but that in the Neck was blacker, and seemed more scar'd. From the Top of the Right Shoulder, sloping downwards towards that Place in his Breast, was a narrow Line of the like scorched Skin; as if somewhat had come in there at the Neck, and run down to the Breast, and there spread broader.

The Buttons of his Doublet were most of them off; which some thought might have been torn off with the *Blas*, getting in at the Neck; and then bursting its Way out: For which the greatest Presumption was (to me) that, besides four or five Buttons wanting towards the Bottom of the Breast, there were about half a Dozen together clear off, from the Bottom of the Collar downwards; and I do not remember, that the rest of the Buttons did seem to be near worn out, but almost new. The Collar of his Doublet, just over the Fore-part of the Left Shoulder, was quite broken asunder, Cloth and Stiffening, straight downwards, as if cut or chop'd asunder by a blunt Tool; only the inward Linen or Fustian-Lining of it was whole, by which, and by the View of the ragged Edges, it seemed manifest to me, that it was by a Stroak inwards from without, not outwards from within.

His Hat was strangely torn, not just on the Crown, but on the Side of the Hat, and on the Brim. On the Side of it was a great Hole, more than to put in one's Fist through it: Some Part of it being quite struck away, and from thence divers Gashes every way, as if torn, or cut with a dull Tool, and some of them of a good length, almost quite to the Edges of the Brim. And besides these, one or two Gashes more, which did not communicate with that Hole in the Side. This also I judged by a Stroak inwards; not so much from the View of the Edges of those Gashes (from which there was scarce any Judgment to be made either way) but because the Lining was not torn, only ript off from the Edge of the Hat (where it was sew'd on) on that Side, where the Hole was made. Yet his Hat not being found upon his Head, but at some Distance from him, it did not appear against what Part of the Head that Hole was made.

The Night following the three Doctors above-mentioned and my self, with some Chirurgeons (besides a Multitude of others) were present at the opening of the Head, to see if any thing could be there discover'd; but there appear'd no Sign of *Contusion*; the *Brain* full and in good Order; the *Nerves* whole and sound; the *Vessels* of the *Brain* pretty full of Blood. But nothing was by any of them discern'd to be at all amiss. Some of them thought, that they discerned a small *Fissure* or Crack in the *Skull*; and some who held it while it was sawing off; said, they felt it jarring in their Hands, and there seemed to the Eye something like it; but it was so small, as that by Candle-light we could not agree it certainly so to be.

Some of the *Hair* on the Right Temples was manifestly singed or burnt, and the lower Part of that Ear blacker than the Parts about it, but soft, and

it might be only the settling of the Blood. The upper Part of the Left Shoulder, and that Side of the Neck, were also somewhat blacker than the rest of the Body; but whether it were by the Blow, which broke the Collar, and *scorched* the round red Spot thereupon, or only by settling of the Blood, I cannot say; yet I think it might very well be, that both on the Head and on this Side of the Neck, there might be a very great Blow, and a *Contusion* upon it, (and it seems to have been so, by the tearing of the Hat, and breaking the Collar, if not also cracking of the *Skull*) and yet no Sign of such *Contusion*, because dying so immediately, there was not time for the Blood to gather to the Part, and stagnate there, (which in Bruises is the Cause of Blackness) and it was but as if such a Blow had been given on a Body newly dead, which does not use to cause such a Symptom of a Bruise, after the Blood ceases to circulate.

Having done with the *Head*, they opened the *Breast*, and found that *Burning* to reach quite through the *Skin* which was in those *scorb'd* Places hard and horny, and shrunk up, so as it was not so thick as the soft *Skin* about it: But no Appearance of any thing deeper than the *Skin*; the Muscles not at all disorder'd or discolour'd, (perhaps upon the Reason that was but now said, of the Head, Neck and Shoulder.) Having then taken off the *Sternum*, the *Lungs* and *Heart* appear'd all well, and well colour'd without any Disorder.

In Hampshire; by Mr. Tho. Neal, n. 14. p. 247.

2. Jan. 24, 1665. One Mr. Brooks of Hampshire, going from Winchester towards his House near Andover, in very bad Weather, was himself slain by Lightning, and the Horse he rode on, under him. For about a Mile from Winchester he was found with his Face beaten into the Ground, one Leg in the Stirrup, the other in the Horse's Mane, his Clothes all burnt off his Back, not a Piece as big as a Handkerchief left intire, and his Hair and all his Body singed; with the Force that struck him down, his Nose was beaten into his Face, and his Chin into his Breast, where was a Wound cut almost as low as to his Navel. The torn Pieces of his Clothes were so scatter'd and consumed, that not enough to fill the Crown of a Hat could be found. His Gloves were whole, but his Hands in them singed to the Bone. The Hip-bone and Shoulder of his Horse burnt and bruised, and his Saddle torn in little Pieces. This was what appeared to the Coroner's Inquest.

At Stralsund in Pomerania; by . . . n. 65. p. 2084.

3. June 19, 1670. (Being Sunday) after several less strong Reports of Thunder, the whole Town, and particularly the Congregation in St. Nicolas Church, (when the Minister was Preaching) was strangely surpris'd with a most terrible Flash of Lightning and a fearful Thunder Clap, which lighted down through the lesser Steeple upon the Body of the Church, and through the large round Hole in the upper Vault within the same, in the Shape (as some observ'd) of a black fiery Ball, directly upon the Altar, causing such an hideous Crack, Fire-flash, Smoak, and Damp there, as if many Fire-Balls had been thrown down thither from the said Vault, and burst'd all at once, begetting a dismal Consternation among the People, and leaving an ill sulphurous Smell behind.

The Candle on the South-side of the Altar was put out by the Blow, the other remain'd burning. Two of the *Chalices* there were overthrown, and the *Wine* spilt, and the *Wafers* scatter'd about: But the empty *Chalice* stood firm. All three were somewhat *smutted* at the Foot, and one of them a little bent there, and in two Places pierced thro', as if it had been by Hail-shot: and the *Wafers-boxes* were likewise a little *smutted* towards the bottom. The *Church-Book* was flung on the inner Passage: The Covers of the Altar were singed in divers Parts, as by Powder, and somewhat burnt and *smutted* here and there, as also torn in some Places. A strong Piece of *Wainscot* with a Picture upon it, behind the great Altar, was split in two. Of the *Church-Clock*, in the *West-End*, at the same time, both the Brass and Iron Wires of the Whole and Quarter-hour Hammers were partly broken, and the rest could not be found; and an oaken Post, fixt in the Wall for the Support of the Dial was half torn, and beneath the same divers Bricks were struck out of the two Head Pillars supporting the Steeple. On the Top of the Southern Steeple, an oaken Gutter and a strong Beam and Supporter were shatter'd.

One of the Ministers, though sitting near the Altar to the South, had no Hurt at all. Divers of the People seated round about the Altar fell down to the Ground with the Fright. One Youth that stood next the said Minister's Pew, not being able to recover his Senses, was carried home. On the North Side of the Altar four Persons fell down, and one of the oaken Seats being split under him that sat thereon, that Person was much hurt by it, and more than any other. Some that stood in or by the Belfrey, near the Clock, were slightly hurt here and there; and among them a Mariner, leaning on a lined oaken Seat there, had his right Arm bruised; and another Man, though but slightly hurt, yet could not remember how he got home from Church.

There issued forth a huge Damp like unto Smoak out of the Southern Steeple, but the *Church-Carpenter* upon Search met only with a present Noise and thick Damp, which tho' it frighted him at first into an Apprehension of Fire, yet getting to the Windows and opening them, the Damp issued with great Violence; but there appear'd no Fire any where, save only a little in the shatter'd Parts of the Steeple, which was soon quenched.

The Church-Dial was also *smutted* in sundry Parts, soiling the gilt Figures that they could scarce be discerned. The gilt Weather-Cocks upon both the Steeples were likewise *smutted* on the one Side of their Tails, without any other Mark. Nor could it be in the least discovered in either of the Steeples, which way the Claps entred by all the Search that was made.

It was observ'd afterwards, that among the eight Persons that were hurt, one who stood in the Belfrey, had the upper back Part of his Cloth-Coat, as also his Shirt and Skin somewhat torn; but the Lining of that Coat, which was Red-Frieze, had no hurt at all.

Another sitting betwixt the rest, in a Pew under the Organs, and leaning on the Door, whilst the Pew-lock (then close to his Body) was so violently struck out, that it hung only by one Nail, had no Damage at all by it himself, nor any other that sat or stood by there, when the Streak happen'd;

happen'd; though they fell all to the Ground by the Fright, at the Instant when it was given.

And as for him that had his Arm bruised, it was somewhat strange that afterwards there was found a Hole passing his Coat, Waist-coat and Shirt, on the Fore-part of his Body, without in the least hurting the Body; the Hole appearing just as shot through. His Waist-coat (being of a red Sarcenet) kept its Colour every where, but at the Place where the Arm was hurt: And the small Silver-Edging was smutted almost every where, and about the Neck too, where the Party wore a Cravat. One half of his Shoe was also torn off, the Soal being pierced as with Hail-shot: And a Piece of his Stockings Foot on the same Foot struck away, near an Hand-breadth, without any other Hurt to either Foot or Leg, but that for some Days that Foot was benumbed.

Lastly, One of them that sat by the Altar, had his Breeches and Leather-Drawers on both Sides pierced through as by Hail-shot, and Part of it plainly scorcht and shrunk up, as by Fire: And divers of such small Holes in his Shirt too, yet without any Hurt in his Body, save that he found some Pain in his Foot. One Side of his Shoe was also torn, and the Soal sideways pierced through, as 'twere, with Hail-shot.

At Dantzick; by Mr. Chr. Kirby, n. 96. p. 6092.

4. About the latter End of *March* and *April*, 1673, we had much and violent *Thunder* and *Lightning*, which had this unhappy Effect upon all the Parcels of *Wheat* and *Rye*, of the last Year's Growth, in our Granaries, that, tho' over-night they were dry, sweet, and fit for shipping, the next Morning they were become clammy and stinking; so that the *Owners*, if they would nor lose their Grain, were forced to cause it to be turned over two or three times a Day; and yet it required six Weeks, if not longer, before it was recovered. This is a thing which often happens to Corn that hath not lain in the Granary a whole Year, or not sweat thoroughly in the Straw before it be thrash'd out.

At Portsmouth; by ... n. 177. p. 1212.

5. *Octob. 23*, 1685. On Board the *Royal-James*, a Flash of *Lightning* and *Thunder* together took the Mast, which was put into her for careening, being a made Mast, and bound with Iron Hoops from one End to the other, and shiver'd it down to the Deck, breaking one of the Iron Hoops in the Body of the Mast, so that Splinters are forc'd out of the middle of the Mast a Foot and half long, (and a *Ball of Fire* to run to and fro on the Deck) insomuch that the Mast is wholly unserviceable, and must be taken out.

On Board the *Coronation*, notwithstanding the Ship's Head was to Windward, a great *Ball of Fire* came into the Gun-room Ports, and threw a Boy out of one of the Ports, and he was drowned; and several Work-men being on Board, as Carpenters, Joiners, and Seamen were struck down and made senseless for some time, and the *Ball of Fire* ran up and struck on the Starboard-side of the Wardrobe, and left a Place scorched round upon the Side, and between the two Ring-bolts, as if it had been a Shot, and beat the Wainscot over to the Side, all scorcht as if with Fire; and run up against the Doors and Hinges, away, and run into several *Balls of Fire* on the Deck
amongst

amongst the Men; and some Part of it broke in at the Windows of the Round-house, and shiver'd off a great deal of the Wainscot, and broke the Glasses of the *Perspective-Glass*, and made a *Hole* through a Letter that lay in the Window eight double, the Circumference of the Musket-Bullet, and no more; it also shivered the Timber that holds the *Ensign-Staff* on the *Poop*.

6. *March 20, 1694*. About eight at Night there arose a very violent Gust of Wind at South-west, which lasted an Hour and an half, during which time it rain'd very fast. A Quarter of an Hour or thereabout after Nine, fell a mighty Storm of Hail intermixt with Rain, which lay very white, and some Depth on the Ground, and to me appeared to have Snow mixed with it. During that Storm happen'd two *Flashes* of *Lightning*, very violent and strange; it was extraordinary blue, and of a sulphurous Smell; it seemed to stand still in the House some considerable time, and was so great that a Gentleman, who sat below Stairs, thought that the House had been on *Fire* above, and that the Flames rolled down Stairs; the Clap of *Thunder*, which immediately followed, seemed to all like the sudden Discharge of five or six Field-pieces; not with that rolling deep Noise *Thunder* usually carries along with it. The second *Flash* and *Clap* followed within a few Minutes of the first, but not with that Violence as the former: Which *Flash* fired the Steeple I cannot say, but a Piece of Wood to which the Lead of the Windows was nailed was set on Fire, and kindled very fast, and might have done a great deal of Mischief, had not the Earliness of the Night and timely Help prevented it. This Storm seemed to run in a direct Course; for several of our Side Towns perceived little of it; and I believe it broke chiefly over us. At *Kettering* one of their Bells, as some say, received some Damage, and the Wires of the Chimes were twisted one with another. The Wind was very blustering all the Night after.

*At Oundle;
by Mr. W. R.*

7. *Aug. 13, 1693*. About three a Clock in the Morning it began to thunder and lighten, and rain; about four a Clock came a Clap of *Thunder* and *Lightning* all at the same Moment of Time, that was so smart and violent, that I thought the Ship had been split in pieces; an Alarm went presently through the Ship, of *Fire, Fire*, the dreadfullest Word that can happen on Board, and put us all into Confusion. But it happen'd to rain briskly about that time, and so with the Help of our Buckets the Fire, which was occasioned by the *Balls* of *Lightning* that came between Decks, was soon put out. In the *Gangway* was one Man knock'd down, and lay sometime before he recovered himself; a second near him was blown almost the Length of the Quarter-deck; a third was burnt all down his Back with the *Lightning* in his Hammock. Our *Main Top Gallant-Mast* was split in pieces, our *Top-Mast* not touched; our *Main-Mast* split from the Top down to the very Deck.

*On Board the
Suffolk in
the Bay of
Biscay; by
Dr. Oliver,
n. 204. p.
911.*

8. *July 24, 1696*. We had an extraordinary pleasant Forenoon, with continual Sun-shine till about half an Hour after three in the Afternoon, when we had some Rain, after which happened two *Claps* of *Thunder*, though not very great, and then a great Shower of *Hail*, in which Time happen'd a third *Clap* which made all our Loss. We were sixteen in Number, none of us happening to be out or absent at the Time. The most Part of them were stand-

*Near Aber-
deen in
Scotland;
by . . n. 222.
p. 311.*

ing

ing about me in the School, hard by my Chamber-door; the two foresaid Claps of *Thunder* being over, we thinking nothing of them; and now there being a great Shower of *Hail*, on a sudden there happen'd such a *Flash* of *Lightning*, which I saw, and as I thought fill'd the whole House; but of the *Clap* I minded nothing, but only I think that I heard as it were some sharp Clink or Sound; but our Neighbours in the Town, such as the Minister and his Wife, told, they never heard a louder: But however, I think all our Loss was by the *Fire*, which was over in an Instant, and after which we had Darkness in the *School*, by reason of the *Smoak*, with a most violent sulphurous Smell, and the burning of some Leaves of Books. There are five Breaches in the Walls, one in the Roof, exactly in Shape like a Cannon-ball; another under the Chimney, a third came thro' the back Wall, and quite thro' the other Wall opposite to it; and the Chimney was split in pieces, and some that came to the School-Door, and made a Breach there, renting the Stones in pieces, and carrying them out. There were four kill'd, and many of the rest hurt, having their Legs or Arms ruined; but are all, I thank God, recovered. And as for my self, I never was in greater Danger; for there was one kill'd before me, another at my Left-hand, and not half a Foot from me there was a Breach made in the middle Wall of my Chamber, and yet, I thank God, I received no Hurt, only I was bled in the Mouth, but how I cannot tell. As to the Childrens Bodies that were kill'd, I found none of their Bones broken; my Brother had a Cut in his Head; and all of them, where they received the Strokes, had their Clothes cut as if it had been eat out with Rats; they all received their Stroakes on their vital Parts, as about their Shoulders, which were in Colour of a brownish-black. All the Children that were killed, were in different Places, and as it were, pick'd out.

At Smyrna,
by Mr. R.
Mawgridge
n. 235. P.
782.

9. Nov. 26, 1696. A sad and astonishing Accident happened to the *Trumbull Galley* by *Lightning* and *Thunder*. For as we lay at Anchor at *Smyrna*, about one of the Clock in the Morning, she was staved in several Places; the *Bulk-head* of her *Round house* was staved all to pieces into the Captain's Cabbin, and hurt his Shoulder, her *Mizen-Mast* was staved all to pieces, and the *Spindle* in the Head of the Mast was melted at both Ends with the *Lightning*; the *Main-Top Sail-Yard* was lashed in the Top, yet notwithstanding the *Yard* was thrown out, and stuck in our *Awning* right an End. The Quarter-Master (one *John Page*) was on the Deck by the *Mizen-Mast*, and one *John Allen*, who were both struck down flat thereon with the *Lightning*. *Page* had one Side of him stupified for three Days, but, under God, I recovered him in six Days; *Allen* was very well the next Day, when his Fright was over. The *Lightning* did strike the Plank for six Foot off of the Outside of the Galley all to pieces, and the Timber was like a Brush, and three Planks of the Cieling were started, whereof two Foot and seven Inches was staved out from the rest, within ten Inches of my Head; my Velvet Cap was hanging on a Nail in the same Piece of Cieling, the Inside whereof, next unto the *Lightning*, had not one Stitch amiss, but the Out-side had all the Seams burst to pieces: A great weighty Nail was started out of the said Cieling, and fell over my Head, and lay upon my Pillow, and I thought my Head with the

Lightning

Lightning had been in a Flash of Fire. Whilst I could but just shut my Eyes and open them again, the *Lightning* went down into the Hold, and ran out like a Train of *Wild-fire*, and burst out through the Gally's side, and rent ten or eleven Foot of the outside Plank off, within a Foot of the Water's Edge. Some of the *Lightning* shot up between the Timbers and the Cieling into the Gun-Room, and staved a Beam, and set three or four Bundles of armed Match all on Fire. The Gunner, *George Hardy*, was lying in his Cabin at the same time, and the *Lightning* blistred one of his Feet, and sing'd his Hair off his Head. The Master's Cabbin was between the Gunner's and mine, but had no Damage.

10. July 27, 1691. In *Everdon Field*, near *Daventry* in *Northamptonshire*, In North-hamptonshire; by Dr. Wallis, n. 236. p. 5. divers were at Work reaping Corn. The Morning was fair and clear; but before Noon there came a violent Storm of *Thunder* and *Lightning* and *Rain*, which caused the Reapers, about twenty in all, to retreat for Shelter to a *Quickset Hedge*, with a Ditch by the Side of it. Of these Persons four were kill'd, viz. *Simon Marriot*, *Robert Marriot*, *Richard Wells*, and *Thomas Burroughs*, and eight others dangerously hurt, of the rest several were struck down, but not much hurt.

Upon the first Tidings of this Accident, Mr. *Edwards* (the Minister of *Badby*) repaired to the Place; where *Robert Marriot* lay on his Back out of the Ditch, having struggled (as was said by the By-standers) after the Stroke. Mr. *Edwards* says, he saw no Marks or Sign of Hurt on the Body: But the Woman who laid him out, and the rest say, there was a Hole about the Bigness of a Goose-shot in the Pit of his Stomach, and many more about his Legs. There was in the Hedge a Pollard-Ash, under which sat *Simon Marriot* and *Richard Wells*; but *Thomas Burroughs* sat at the Distance of two or three Yards from thence. In this Tree were cut or raised four (or more) Groves or Furrows, from the Top to near the Bottom, deeper than the Bark, and about an Inch broad each of them, on that Side of the Tree on which the Men sat; but no Damage appeared on the Tree elsewhere, there being a Knot on the opposite Side, which is supposed to have diverted the Stream of the fiery Matter. The green *Thorns* were scorched, and the Place smelt rank of *Sulphur*.

Simon Marriot had the Crown of his Hat cut into the Shape of a bearded Arrow, and at the Band-place cut smooth, almost round about from the Brim. His Clothes on one Shoulder cut jaggedly to the Skin, where was a Scar about four Inches in length, of a long oval Figure, the transverse Diameter whereof was deepest, of a darkish red Colour, as hard as *Horn* all over. He had Snuff on his Hand, as if just ready to take it.

Richard Wells had a little Dog on his Lap, or between his Legs, dead. His Hand upon the Dog's Head, his Eyes open, and with Bread and Cheese (or one of them) in his Hand, as if going to give the Dog a Bit. His Shoulder (as his Relations say) was struck down, and in a manner severed from his Body.

Thomas Burroughs sat as looking up to the Heavens, his Head turning toward one Side, as viewing the Clouds, his Eyes open. He had in his Pocket

a Copper Tobacco-Box, which had one little round Hole struck quite thro' it; and a little of the Metal on one Side seemed to have run. By these Postures it is evident they died in a Moment.

Mr. *Edwards* adds, that he took *Simon Marriot's* Hat, and some of his Clothes, and held them against the Light, and they appeared full of Holes, as a Skimmer or Cullender. But (at which he wondred most) the Woman who laid them out, told him, their Buttocks which sat upon the Ground were pitifully mangled, and their Privy-Members rent and torn to pieces; and more especially those of *Thomas Burroughs*, as if small Bars of red hot Iron had been thrust up into them in many Places.

The Hair of their Heads was burnt very much. Some had no Harm that were hard by: But others were wounded at a Distance, and their Wounds were cured with more Difficulty than ordinary Burns.

It was (before the Storm) a pretty still Day. But before each Thunder Clap was heard a great whirling Noise in the Trees like Wind. The Lightning was observed by Persons at a Distance, all falling perpendicularly upon them. Those who recovered had their Clothes full of Holes, as if they had been shot through. Not a Drop of Blood appeared upon any of them. Their Hurts like dry, scorched, scarred, or healed Wounds.

Simon Marriot and *Robert Marriot* were struck back, the other two supported, as is supposed, by the Hedge at their Back, continued in the Posture wherein they were kill'd three or four Hours after, when Mr. *Richard Butler* of *Preston* saw them.

Several of those who were hurt, were taken up for dead, but soon came to themselves without any Application: But some of them were fain to be carried home.

William Gregory's Wife had four little Holes in her Knee, like Shot-holes, which turned to Sores, and had Cores come out of them.

Mary Bird (a Woman with Child) had all over her Body near an hundred Wounds, some as large as a Man's Hand, on each Arm one, and one on each Side of her Belly. Out of most of her Wounds came Cores, some bigger, some less; the biggest were bigger than a Walnut, dry and black like Leather. She had two Sores on the Soles of her Feet, but her Shoes and Stockings not touched. She sate next to those that were kill'd. She was taken out of the Ditch for dead, and was suppos'd to be kill'd. She was sensible of the Stroke, and sensible that her Husband look'd pale, and then swooned away. She and her Husband were both blooded, she within an Hour after, and her Husband eight Hours after; and they bled freely. Their Legs were mightily swell'd before they were carried out of the Field. The Woman was very sore, and full of Pain, so that she could hardly bear any Clothes to touch her. She was three Weeks ill before she could rise, and continued ill about a Quarter of a Year. No Medicines used for Burns did any good, but occasioned great Torment to her. The first that they perceived to do good to her was Oil of *St. John's-Wort*, and after the Cores were come out, the *Black-Salve*. She went out her full Time: The Child had no Marks or Blemish at all upon this Occasion; and is yet living. About that

that Time of the Year she hath been blooded ever since. She finds a great Tingling, and hath little Pimples like Stinging of Nettles, and cannot be well until she hath been blooded.

The Wounds of all those that were hurt, were like those of this Woman, but slighter; and some of them had no Cores come out of them.

This is the best Account I can give you out of the broken Remarks which I had in Writing from Mr. *Edwards* and Mr. *Butler*, the two Gentlemen above-mentioned.

11. Dec. 22, 1698. *Jeremiab Skelton* at *Warley*, in the Vicaridge of *Hallifax* in *Yorkshire*, observing a Storm coming upon him, step'd aside for Shelter within a Barn-Door, and while there, was struck with a dreadful *Flash* of *Fire*; a young Woman that lived with her Father, in the House that belonged to this Farm, being sadly affrighted with the *Thunder* and *Lightning*, (for Part of the sulphurous Matter came down the Chimney, and filled the House with a strong Scent, like that of Gun-powder after firing) she leaves the House, and not seeing the young Man about the Barn, goes with speed and tells the Family he was related to, that she fear'd he was slain. They came to the Barn, and found it even so: A sad Spectacle; the young Man cast down and many Stones about him, he was laid upon his Face, wholly naked, save a small Part of his Shirt about his Neck, and a very little of a Stocking upon one Foot, and so much of a Coat-Sleeve as covered the Wrist of one Arm; his Clogs driven from his Feet, one not to be found, and the other cloven, his Hat not to be found after Search; and the rest of his Garments torn into small Shreds, and cast at considerable Distances one bit from another; the *Hair* of his *Head* and *Beard* singed, as though it had been with a Candle, and a little Hole below his left Eye, which they supposed might be made with the Fall upon a Stone; for there was a great Breach made upon the Barn, the Door-tops, both of Stone, broken, and the Wall above them fallen, with the Slate and Water-Tables.

In *Yorkshire*, 1698;
by Mr. *Ral.*
Thoresby,
n. 249. p. 51.

12. April 27, 1700. We had (at *Leeds* in *Yorkshire*) a pretty severe Storm of *Thunder* and *Lightning*; one Clap particularly was very loud, and seem'd to me to be very low and near us. It fell upon a Cottage, and broke down Part of the Chamber Chimney, and thence made its Way through a Chink or Nick in the Floor to the lower Room, whereby the Flame thus contracted was either more intensely hot, or at least directed more immediately to a Shelf, where it melted several Holes in two Pewter Dishes; it melted also, and run into little Lumps, several Places in a Pewter Candlestick, and of a Brass-Mortar, yet burnt not some bits of Fringe, and other combustible Matters within it; it burnt also some Holes in a Tin Vessel, and smutted a white Stone Plate it stood upon, as if it had been with *Lamp-Black*, and filled the Room with such a *Bituminous Smell*, (like fired Gun-powder) as almost stifled the poor Woman, who was all alone in the House: But upon opening the Door, received no farther Damage. I bought the Candlesticks, to preserve as a Memorial of so uncommon an Accident.

In *Yorkshire*, 1700;
by Mr. *R.*
Thoresby,
n. 264. p.
577.

I have enquired of one in that Neighbourhood concerning a more fatal Accident, of which the *Parish-Register* has this Note. *Sept. 2, 1672*, was buried *Thomas*, the Son of *James Lambert, Junior*, deceased, of *Holbeck*, slain the Day before, being the Lord's-Day, by a *Thunderbolt*. His Skin, as I am informed, was perfectly burnt black, and was shrunk up hard like Parchment, or Leather burnt with Fire. There were other Children in Company, who were also cast down by the Storm, amongst whom the Party I spoke to had a Brother and Sister; he had a Pair of new Stockings burnt off his Legs, and himself was so scorched, that he never recovered his natural Complexion: She having a Waste-coat clasp'd before (as the Fashion then was) was so burnt betwixt her Breasts, that the Scars thereof remain to this Day: Another had the stiffened Neck of his Doublet struck off.

But all recovered except *Lambert's Boy*, who was found with his Face upwards, whereas all the rest had theirs to the Earth: Which reminds me of our Coal-Miners Practice, who when any swoon away by their sulphurous Damps, dig a *Hole* in the Earth, and lay 'em on their Bellies, with their Mouths in it, which, if it prove not an absolute Suffocation, recovers them.

The Direction of Ship-Compasses changed with Thunder and Lightning; by...
n. 127. P. 647.

LX. 1. Mr. *Haward*, who has been Master of several Ships, and is a Man of good Credit, tells me, That in a Voyage to *Barbadoes*, in Company of another Ship commanded by one *Grofton* of *New-England*, they were, in the *Latitude*, as I remember, of *Bermuda*, suddenly alarmed with a terrible Clap of *Thunder*, which broke this *Grofton's* Fore-mast, tore his Sails, and did some Damage to his Rigging: But by that Time the Noise, together with the Danger of this frightful Accident was past, Mr. *Haward*, to whom this *Thunder* had been more favourable, was however no less surprized, to see his Companion's Ship steer directly homeward again. When they were almost out of Call, he tack'd and stood after them, and found, That Mr. *Grofton* did indeed steer by the right Point of his Compass, but that the Card was turn'd round, the North and South Points having changed Positions, and though with his Finger he brought the *Flower de Lys* to point directly North, it would immediately, as soon as at Liberty, return to this new unusual Posture, and upon Examination, he found every Compass in the Ship of the same Humour: Which strange and sudden Accident he could impute to nothing else but to the Operation of the *Lightning* and *Thunder* newly mentioned. He adds, that he lent *Grofton* one of his Compasses to finish the Voyage, and withal, that those *Thunder-strucken* ones did never, to his Knowledge, recover their right Positions again.

By Sir R. S.
n. 157. P. 520.

2. *July 24, 1681*. The Ship called the *Albemarle*, whereof Mr. *Edward Lad*, was then Master, being a hundred Leagues from *Cape Cod*, in Lat. 488, about 3 h. p. m. met with a *Thunder-storm*, the *Lightning* burnt the Main-Top-Sail, split the Main-Cap in pieces, rent the Mast all along, there was in special one dreadful Clap of *Thunder*, in Report bigger than that of a great Gun, at which all the Ship's Company were amazed; then did there fall something from the Clouds upon the Stern of the Boat, which broke into many

many small Parts, split one of the Pumps, the other Pump much hurt also; it was a bituminous Matter, *smelling* much like fired Gun-powder: It continued burning in the Stern of the Boat; they did with Sticks dissipate it, and poured much Water on it, and yet they were not able by all that they could do, to extinguish it until such Time as all the Matter was consum'd.

When Night came, observing the Stars, they perceived that their *Compasses* were *changed*; as for the *Compasses* in the *Bittakle*, the *North-Point* was turned clear *South*. There were two other *Compasses* unhung in the Locker in the Cabbin, in one of which the *North Point* stood *South*, like that in the *Bittakle*; as for the other, the *North Point* stood *West*; so that they failed a thousand Leagues by a Needle, whose *Polarity* was quite *chang'd*. As for the *Compass* wherein the *Lightning* had made the Needle to point *Westward*, since it was brought to *New-England*, the *Glass* being broken, it has, by means of the *Air's* coming to it, wholly lost its *Virtue*.

Mr. *Edward Randolph* (who has been four times employed to *New-England* in his Majesty's Service) being enjoyned by Mr. *Flamsteed* to make Enquiry into this Matter, at his Return to *Boston* in *Dec.* 1683, spoke with Mr. *Lad* himself. He affirmed the same thing, and dictated to him an Account suitable to what you have. But that which you have, was in the Hands of Mr. *Mather*, a Minister, to whom Mr. *Lad* had also presented one of the *Compasses*, as he had done the other to an *English Merchant* in *Amsterdam*, who gave it to the State-house.

LXI. 1. About *Christmas* 1693, at *Harlech* in *Merioneth-shire*, sixteen Ricks of Hay and two Barns, whereof one was full of Corn, the other of Hay, were set on Fire by a kindled *Exhalation*, which was often seen to come from the Sea, and lasted at least a Fortnight or three Weeks; and it annoyed the Country, as well by *poysoning* their Grass, as *firing* the Hay, for the space of a Mile, or thereabouts. Such as have seen the Fire, say it was a blue weak Flame, easily extinguished, and that it did not the least Harm to any of the Men, who interposed their Endeavours to save the Hay, tho' they ventured (perceiving it different from common Fire) not only close to it, but sometimes into it. All the Damage sustained happen'd constantly in the Night. Dec. 24. *Richard Griffith* of *Lechwedd-du*; *Humphrey Owen* of *Garreg-wenn*. and *Richard Davydb* of *Erw-wenn*, each of them lost a Rick of Hay. 27. That Night was burnt one Rick of Hay of *John Philips* of *Tynysanvihangel y Traltbau*, two Ricks of Hay of *Griffith John Owen* of *Cefn-Trevorbach*, and *Katharine William*, Widow, of *Cefn Trefor suawr*, lost two Ricks. 29. That Night *Francis Evans* of *Glasf-vryn* had one Rick burnt. *Richard Davydb* of *Erw-wenn* had a Barn full of Hay of three Bayles of Buildings, burnt down to the Ground.

A Fiery Exhalation or Damp; by Mr. Maurice Jones, n. 208. p. 49.

There are three small Tenements in the same Neighbourhood (call'd *Tydbin Sion Wyn*) whereof the Grass is so infected, that it absolutely kills all manner of Cattle that feed upon it. The Grass has been infectious these three Years, but not thoroughly fatal till this last.

By Mr. Edw.
Lhwyd, n.
213. p. 223.

2. An intelligent sober Person that lives near *Harlech*, assures me, that the *Fire* still [*Aug. 1694*] continues there; that it is observed to come from a Place call'd *Morva bychan* in *Caernarvonshire*, about eight or nine Miles off [over Part of the Sea.] That Cattle of all sorts, as Sheep, Goats, Hogs, Cows, and Horses, still *die* apace; and that for certain any great Noise, as Winding, of Horns, Drums, &c. does *repel* it from any House or Barn, or Stacks of Hay, upon Account of which Remedy they have had few or no Losses since *Christmas*: That it happened, during this Summer, at least one Night in a Week, and that commonly either *Saturday* or *Sunday*; but that now of late it appears something oftner. The Place from whence it proceeds is both sandy and marshy.

Fairy Circles,
by Mr. Jelf-
sop, n. 117.
p. 394.

LXII. I have often been puzzled to give an Account of those *Phænomena*, which are commonly called *Fairy-Circles*. I have seen many of them, and those of two sorts; one sort *Bare*, of seven or eight Yards Diameter, making a round Path something more than a Foot broad, with Green Grass in the middle; the others like them, but of several Bignesses, and encompassed with a Circumference of Grass, about the same Breadth much *fresher* and *greener* than that in the middle. But my worthy Friend Mr. *Walker*, gave me full Satisfaction from his own Experience. It was his Chance one Day to walk out among some Mowing Grass (in which he had been but a little while before,) after a great Storm of *Thunder* and *Lightning*, which seemed by the Noise and Flashes to have been very near him: He presently observed a round Circle of about four or five Yards Diameter, the Rim whereof was about a Foot broad, newly *burnt bare*, as the Colour and Brittleness of the Grass Roots did plainly testify. He knew not what to ascribe it unto but the *Lightning*, which, besides the odd *Capricio's* remarkable in that Fire in particular, might without any Wonder, like all other Fires, move round, and burn more in the Extremities than the middle. After the Grass was mowed, the next Year it came up more *fresh* and *green* in the Places burnt, than in the middle, and at Mowing-time was much taller and ranker.

The Cause of
Lightning
and Thun-
der consider-
ed; by Dr.
Lifter, n.
157. p. 517.

LXIII. 1. There are two sorts of Instances (that often occur in History) which very much favour my Opinion, That *Thunder* and *Lightning* owe their Matter from the sole *Breach* of the *Pyrites*.

The first sort of them are those which tell us, that in *Italy* it rained Iron in such a Year, and in *Germany* a great Body of Iron-stone fell at such a time; the like *Avicen* affirms. *Julius Scaliger* says, that he had by him a Piece of Iron which was rained in *Savoy*, where it fell in divers Places. *Cardan* reports 1200 Stones to have fallen from Heaven, and one of them weighed an hundred and twenty Pound, some of them thirty, some forty Pound, very hard, and of the Colour of Iron. Now that which is very remarkable (says *Gilbert*, where those Instances are reckon'd up,) and a very probable Argument for the Truth of such like Instances, is, that it is no where recorded, that it ever rained Gold or Silver Ore, or Tin, or Lead; but Copper hath been also said to have fallen from the Clouds.

But

But where-ever the *Pyrites* is mentioned by the Ancients, it is always to be understood of the *Copper Pyrites*; they scarce having had any Knowledge of the *Iron Pyrites*. And therefore the raining of Copper makes it yet more probable, because of its great Affinity with Iron.

Now this *Ferrum* or *Æs Nubigenum*, if there was ever any such, was con-
creted of the *Breath* of the *Pyrites*, which we have elsewhere shewn to be the *Pyrites, ex tota Substantia*.

The other Instance, (which is owing to our Registers) is of *Lightning* being *Magnetick*. This I am sure of, I have a petrified Piece of Ash, which is *Magnetick*; that is, the *Pyrites in Succo*; which makes it probable it may be *Magnetick* also in Vapour.

Vid. Sup. §. LX.

2. *Thunder* and *Lightning* are so very like the Effects of fired *Gun-powder*, that we may reasonably judge them to proceed from like *Causes*. Now the principal Ingredients in *Gun-powder* are *Nitre* and *Sulphur* (the Admission of Char-coal being chiefly to keep the Parts separate, for the better kindling of it.) So that if we suppose in the Air a convenient Mixture of *Nitrous* and *Sulphurous* Vapours, and those by Accident to take Fire, such *Explosion* may well follow, with such Noise and Light, as in the firing of *Gun-powder*. And being once kindled, it will run from Place to Place, as the Vapour leads it, as in a Train of *Gun-powder*, with like Effects.

The Cause of Hall, Lightning, and Thunder considered, by Dr. Wallis, n. 231. p. 655.

This *Explosion*, if high in the Air, and far from us, will do no Mischief, or not considerable; like a Parcel of *Gun-powder* fired in the open Air, where is nothing near to be hurt by it: But if near to us (or amongst us) it may kill Men or Cattle, tear Trees, fire *Gun-powder*, break Houses, or the like; as *Gun-powder* would do in the like Circumstances. This Nearness or Farness may be estimated by the Distance of Time between seeing the *Flash* of *Lightning*, and hearing the Noise of the *Thunder*. For though in their Generation they be simultaneous; yet (*Light* moving faster than *Sound*) they come to us successively. I have observed that commonly, the Noise is about seven or eight *Seconds* after the *Flash*, (that is, about half a Quarter of a Minute;) but sometimes much sooner, in a *Second* or two, or less than so, and almost immediately upon the *Flash*. And at such time, the *Explosion* must needs be very near us, or even amongst us. And, in such Cases, I have (more than once) presaged the Expectation of *Mischief*, and it hath proved accordingly.

Now, That there is in *Lightning* a *sulphurous Vapour*, is manifest from the *sulphurous Smell* which attends it, and a Sultry Heat in the Air which is commonly a Fore-runner of *Lightning* soon after. And that there is also a *nitrous* Vapour with it, we may reasonably judge, because we do not know of any Body so liable to a sudden and violent *Explosion*.

As to the kindling of these Materials, in order to such *Explosion*, I am told that a Mixture of *Sulphur* and *Filings* of *Steel*, with the Admission of a little *Water*, will not only cause a great Effervescence, but will of it self break forth into an actual Fire. I say, a little *Water*, because too much will hinder the Operation, or quench the Fire, which I take to be the Cause of the Bath Waters.

n. 233. p. 729.

Waters, and other *hot Springs*, where *Steel* and *Sulphur* cause a great *Efferescence*, but no *Flame*.

n. 231.
p. 657.

So that there wants only some *Chalybeat* or *Vitriolick Vapour* (or somewhat *equivalent*) to produce the whole Effect (there being no want of aqueous Matter in the Clouds.) And there is no doubt, but that amongst the various *Effluvia* from the Earth, there may be copious Supplies of Matter for such Mixtions.

n. 233.
p. 730.

The same Account may be also given of *Ætna*, (and other *Burning-Mountains*;) where the Mixture of *Steel* and *Sulphur* may give a *Flame*; which is oft attended with prodigious *Explosions* (and *Earthquakes*) from great Quantities of *Nitre*, as in springing a Mine.

n. 231.
p. 657.

This may also suggest somewhat as to the *Generation* of *Hail*, which is very oft an Attendant of *Thunder* and *Lightning*. 'Tis well known, in our artificial *Congelations*, that a Mixture of *Snow* and *Nitre* (or even common Salt) will cause a present and very sudden *Congelation* of *Water*. And the same in Clouds may cause that of *Hail-stones*. And the rather, because there seems somewhat like *Snow*, rather than *Ice*, in the midst of them. And as to those in particular so very large (as to weigh half a Pound, or three Quarters of a Pound) supposing them to fall from so great a Height, as 'tis manifest they did by the Violence of their Fall: 'Tis very possible, that, though their first Concretion, upon their sudden *Congelation*, might be but moderately great, as in other *Hail*, yet in their long Descent, if the Medium through which they fall were alike inclined to *Congelation*, they might receive a great Accession to their Bulk, and divers of them incorporate into one. Like as in that strange Shower of *Hail* in *December* 1672, wherein there did hang on the Trees a great deal in the Form of *Icicles* a Foot or more in length.

Vid. sup. s.
XLIV.

Vid. sup. s.
LL.

n. 236. p. 9.
Vid. sup. s.
LIX. 10.

These Considerations may also furnish us with some Account of the natural Causes of those particular Circumstances which attended the Accident at *Everdon*, where four Persons were kill'd, and others hurt with *Lightning*.

It seems to me, that in and over the Ditch there was Plenty of some *Caulstick Vapour* of a like Nature with the Ingredients of *Gun-powder*: And perhaps even under those who were killed or wounded. And if this *explosive* Quality were attended with that of *Glaciation*, as *Thunder* is often accompanied with *Hail* (*Nitre* being a proper Efficient of both,) there might be such Concretions, in the Nature of *Hail*, as might (by such *Explosion*) be scattered like *Hail-shot* out of a Gun, and cause such *Holes* as are said to have been in the Clothes and Flesh of those Persons. And what is said to have been observed by others at a Distance, like a *Ball of Fire* falling down directly upon the Place, might be a Propagation of the *Flame* kindled above, and continued, as the *Vapour*; directed it, to the Place (as would be in a Train of *Gun-powder*) and might there hurt some, and spare others, according as it was here or there more copious. For we are not to presume that it was in all Places equally mixed.

The *Cores* which came out of the Wounds, seem like *Escars* made by a *Caulstick*

Cautstick or other Burnings. And I take them to be scorched Skin, mortified, (beat into the Flesh by that *Hall-Shot*) and appearing like burnt Leaves: Which must be worked out before the Wound could be healed; as is usual, when other heterogeneous Matter is forced into the Flesh.

That some of the People not far off, might be thrown down, and not otherwise considerably hurt, is not strange; who might be within the *Blast*, though not within the Reach of the Fire; as we see in the *Explosion* of *Gun-Powder*, (to which I take this to be very like) when Windows (and other things at a distance) are shaken and shatter'd by the *Blast*, or great Concussion of the Air, though the *Flame* do not reach them.

LXIV. 1. Decemb. 25. 1666. In the Evening here (*viz.* at *Madrid*) was a great *Halo* about the *Moon*; the Semidiameter whereof was about $23^{\circ} 30'$. *Aldebaran* was just in the North-East Part of the Circle, and the two *Horns* of *Aries* just enclosed by the South-West of the Circle, the *Moon* being in the Center. I note this the rather, because 5 or 6 Years ago, *viz.* Nov. 21, 1661. an Hour after Sun-set, I saw a great *Halo* about the *Moon*, of the same Diameter, at *Tangier*, the *Moon* being very near the same place where she was now.

2. May 12. 1667. An *Halo* or Circle about the *Sun*, was observ'd by the *Philosophical Society* at *Paris*. The Diameter of this Circle was found to be of 44 *Degrees*, and the Breadth of the Limb thereof, about half a *Degree*. The upper and lower Part were of a *vivid red* and *yellow*, with a little *purple* Colour, but especially the upper; the *red* was within the Circle. The other Parts appeared but *whitish* and of little Clearness. The Space within the *Halo* was a little darker than that about it, especially towards the Parts that were coloured. Besides, there was seen the *Proportion* of another great Circle, which touched the *Halo* above, and whose Extremities were bent downward, as is represented in the *Figure*. This *Portion* of a Circle had also its Colours like those of the *Halo*, but fainter. The height of the *Sun* at the beginning of the Observation, was about 46 *Deg.* There were in the Air little white Clouds, which somewhat tarnish'd the blue Colour of the Heavens, and lessened the Brightness of the *Sun*, which shone as in an *Eclipse*. The Weather was cold, considering the Season of the Year; and it was affirmed for certain, that it had frozen the Night before. This *Halo* appear'd in the same Beauty and Splendor of Colours unchanged from 9 in the Morning (when it began to be observ'd) until about half an Hour past 10; after which time it became fainter and fainter till two of the Clock in the Afternoon (when it ended,) after it had resumed a little more Force sometime before it disappear'd.

3. Jan. 1. St. N. 1676. H 3. 46'. Durante *Eclipsi*, ingens *Halo Lunam* cinxerit.

4. Aug. 21. 1676. At 12 h. 40'. At Night a *Halo* encompassed the *Moon*; in whose Circumference was *Saturn*, the *Pleiades*, *Capella*, and the following of the Foot of *Persens*.

VOL.

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LXV. 1. April

Halo's, At Madrid; by E. of Sandwich, n. 22. p. 390.

At Paris, by M. n. 60. p. 1065

Fig. 26.

At Dantzick; By M. Hevelius, n. 124. p. 589. At Oxford; By Mr. Halley, p. 129. p. 724.

Parhelia ob-
served in
France; By
M———
13. P. 219.

LXV. 1. April 9. 1666. About half an Hour past 9, there appeared three *Circles* in the *Sky*. One of them *SCHN*, was very great, a little interrupted, and *White* every where, without the Mixture of any other Colour. It passed through the midst of the *Sun's Disk*, and was parallel to the *Horizon*. Its Diameter was above 100 *Degrees*, and its Center not far from the *Zenith A*.

The second *DEBO*, was much less and defective in some places, having the Colours of a *Rainbow*, especially in that Part which was within the great Circle. It had the true *Sun R*. for its Center.

The third *HDN*, was less than the first, but greater than the second; it was not entire, but only an *Arch* or Portion of a *Circle*, whose Center was far distant from that of the *Sun*, and whose Circumference did by its Middle join to that of the least Circle, with which it was confounded at *D*, and intersected the greatest Circle, by its two Extrems. In this Circle were discerned also the Colours of a *Rainbow*, but they were not so strong, as those of the second.

At the Place, where the Circumference of this third Circle did close with that of the second, there was a great Brightness of *Rainbow-Colours*, mixt together: And at the two Extremities, where this second Circle intersected the first, appeared two *Parhelia's* or *Mock-suns*, *H, N*; which shone very bright, but not so bright, or so well defined, as the true *Sun*. The midst of these two false *Suns* was white and very luminous: And their Extremities towards *DI*, were tinged with the Colours of a *Rainbow*. The false *Sun H*, that was towards the South, was bigger, and far more luminous than that towards the East.

There was also upon the first great Circle, a third *Mock-Sun*, *C*, situated to the North, which was less, all white, and far less shining than the two others. There was a Space very dark betwixt *R* and *D*.

This Appearance is look'd upon as one of the notablest that can be seen, by Reason of the Excentricity of the Circle *HDN*, and because that the *Parhelia* were not in the Intersection of the Circle *DEBO* with the great Circle *SCHN*, as they appear'd at *Rome*, March 29. 1629, but in that of the Semicircle *HDN*.

2. A Learned Jesuit, call'd Father Michael, who lives at *Presburgh*, communicated to me an Account of two *Parhelia's*, which were seen Jan. 30. 1669. St. N. about one of the Clock in the Afternoon, over the City of *Cassovia* in *Hungary*.

In Hungary;
By Dr. Edw.
Brown, n.
47. P. 953.

There was one on each side of the true *Sun*, and they were so resplendent, that the naked Eye could not bear the Brightness thereof. One of them (the lesser of the two) began to decay before the other, and then the other grew bigger, and continued well nigh two Hours projecting very long Rays from it self. They were both, on that Part which was towards the *Sun*, tinged with a pale Yellow, the other Parts being somewhat fuscous. There were at the same time seen several *Rainbows*, together with the Segment

ment of a great *white Circle*, of a long Duration, passing through the two *Parbelia's* and the *Sun*: And all this at a time, when the Air was almost free from Clouds, though here and there were scatter'd some very thin ones.

3. *An.* 1670. *Oct.* 11. *St. N. H.* 7. 40' *Tres Parbelii apparuerunt.*

4. *Feb.* 5. 1674. *St. N.* Not far from *Marienburg* in *Borussia*, I saw the *Sun* (in a *Sky* every where serene enough) being yet some *Degrees* above the *Horizon*, and shining very bright, yet lanching out very long and reddish Rays, 40 or 50 *Degrees* toward the *Zenith*. Under the *Sun*, towards the *Horizon*, there hung a somewhat dilute small Cloud, beneath which there appear'd a *Mock-Sun*, of the same Bigness (to Sense) with the *true Sun*, and under the same Vertical, of a somewhat Red Colour. Soon after, the true *Sun* more and more descending to the *Horizon* towards the said Cloud, the *spurious Sun* beneath it grew clearer and clearer, so that the *Reddish* Colour in that *apparent Solar Disk* vanish'd and put on the *genuine Solar Light*, and that the more, the less the *genuine Disk* of the *Sun* was distant from the *false Sun*: Till at length, the upper *true Sun* passed into the lower counterfeited one, and so remained alone.

At Dantzick; By M. Hevelius, n. 66. p. 2026. At Marienburg in Borussia; By M. Hevelius, n. 102. p. 26. Fig. 28.

Fig. 39.

Upon this Appearance there soon followed here an exceedingly intense and bitter *Frost*, whereby the whole *Sinus Puzensis* was frozen up, from this Town of *Dantzick*, as far as *Hela* in the *Baltick Sea*, which lasted unto the 25th of *March*, and the *Bay* was frozen so hard, that with great Safety People ran out into it with Sleds and Horses, for several of our Miles.

5. *Aug.* 28, 1698. About 8 a Clock in the Morning, some Persons at *Sudbury* in *Suffolk* saw the Appearance of *three Suns*; 'tis said, then the Apparition was most full, or a little after. About $\frac{1}{2}$ an Hour after 8, I myself saw it; there was in the East, a dark, dusky, watry Cloud, and below it towards the Middle, was the *true Sun*, shining with fierce and piercing Beams, that Persons could not look upon it; on each side were the *Reflections* with the *true Sun* in the Middle. Elsewhere much of the Firmament was of an azure, light-blue Colour. The Circles which I saw, were not of *Rainbow* Colours, but *white*. There was also, higher in the Firmament, more over our Heads, and toward the South, at the same time, at a considerable Distance from the other, the Form of a Half Moon; but I think it was more than twice the Bigness of a Half Moon, with the Horns turned upward, and within of a fiery *Red* Colour, and more like a *Rainbow* Colour; these all faded gradually; they continued, in all, I suppose two Hours.

In Suffolk; By M. Petre, n. 250. p. 107.

6. *Feb.* 26. 169 $\frac{1}{2}$. About half an Hour after 3 in the Afternoon, chancing to look out of a Window that faced South-East, I saw, not far from the South to the Westward, an Appearance of somewhat not much unlike the *Sun* when seen through Clouds, viz. with its Periphery not exactly defined: From which it likewise differed, in that one half of it was coloured deep *Red* and *Yellow*, the other *White*. I went immediately into the Garden, and saw an Appearance exactly like the former, but on the opposite Side of the *Sun*. The Distance of this was 23° from the *Sun*, to the Westward; but before I could take the Distance of the Eastern one, it vanished,

At Canterbury; By Mr. St. Gray, n. 251. p. 826.

but soon after re-appear'd, and then I perceived manifestly, that they were both situate in the Extremities of a *Semicircle*, whose Center was the *Sun*, passing betwixt it and the *Zenith*. This Appearance continued about half an Hour.

At Canterbury; by Mr. St. Gray, n. 262. p. 535. Fig. 31. 7. Apr. 7th, 1699. Between 4 and 5 a Clock, there appeared on each side the *Sun* *A*, a *Parhelion*, *BC*, connected by an *Halo* *BDC*, of the usual Diameter; they had each of them a *Tail* of a *whitish* Colour, extended opposite to the *Sun*, of about 15 or 20 Degrees in Length; the upper part of the *Halo* was touched at *D*, by the Arch of a Circle, whose Ends were turned towards the *Zenith* *Z*; it had the Colours of the *Iris*, but faintly; betwixt this and the *Zenith* was another Portion of a Circle *E*, which had the Colours of the *Iris* with greater Vivacity than the former.

Rainbows observed in France; By M. Estienne n. 13. p. 221. Fig. 32. LXVI. 1. An. 1665. Aug. 10. About half an Hour past 6 in the Evening two odd *Rainbows* appeared at *Chartres* in *France*, crossing one another almost at right Angles. The *Rainbow*, which was opposite to the *Sun*, in the usual Manner, was more deeply colour'd, than that which cross'd it: And its greatest height was about 45 Degrees. The feebler *Rainbow* lost one of its Legs, by growing fainter, about 20 Degrees above the stronger; and the Leg below appeared continued to the *Horizon*. This seem'd to be a Portion of a great Circle; and the stronger was but a Portion of a small Circle, as usually.

The *Sun*, at their Appearance, was about 6 Degrees high above the *Horizon*. The River of *Chartres*, which runs very near from South to North, was betwixt M. *Estienne* (the Observer) and the *Rainbow*, and he stood level with the River, whence he was distant not above 150 Paces.

At London; By Mr. Edm. Halley n. 240. p. 195. 2. Mar. 11th, 1696. It rain'd pretty thick a small Rain, and the *Sun*, about 2 of the Clock, shone directly down *Abchurch-Lane*, as I was passing along it with my Back to him, when I perceived the Arch of the *primary Rainbow* in the Drops of Rain, spanning the Street like an Arch of a Building under which I was to pass, the Crown whereof was not much higher than my Head, and the Diameter thereof scarce so wide as the Street, which is but 5 Yards; and it moved along with me as fast as I went; the Colours being very vivid and distinct, though the Arch it self appear'd but narrow, and the Houses were every where behind it. This, tho' very uncommon, will not appear strange to those who have well consider'd the Nature of the *Iris*.

At Chester; By Mr. Edm. Halley, n. 240. p. 193. 3. Aug. 6th, 1698. Between 6 and 7 a Clock in the Evening, I observed an *Iris*, exceedingly vivid, as to its Colours, at first on the South-side only, but in a little Time with one entire Arch; and soon after, the Beams of the *Sun* being very strong, there appear'd a *secondary Iris*, whose Colours were more than ordinary bright, but inverted, as usually: That is, the *Red* was inwards, which in the *primary Iris* is outward, and *e contra* for the *Blues*. But what I took most notice of was, that with these two concentrick Arches, there appear'd a third Arch, near upon as bright as the *secondary Iris*, but coloured in the Order of the *Primary*, which took its Rise from the Intersection of the *Horizon* and *primary Iris*, and went cross the Space between the two, and inter-

intersected the *Secondary*, as in the *Figure AFCC* intersects the *secondary Iris EFGD*, dividing the Arch *ED* into three equal Parts, as near as I could *Fig. 33.* then guess: But at first the Arch *AF* did not appear, which afterwards became as bright as the former. I observed the Points *F*, and *G*, to arise, and the Arch *FG*, gradually to contract, till at length the two Arches *FHG*, and *FG*, became coincident; when, for a great space, the *secondary Iris* lost its Colours, and appeared like a white Arch at the top. I observed also, that at the Points *F*, and *G*, the Intersection of the interior *Red* of the *secondary Iris*, and the exterior *Red* of the Arch was much more intensely red than the outward Limb of the *primary Iris*, and that during the whole Appearance, the upper Part of the *third Iris* was not at all visible, beyond the Intersections *FG*. This uncommon Sight entertained me for about 20 *Min.* when the Clouds blowing away, the whole vanished. I was at first amazed with the Sight, but afterwards, recollecting that the Sun shone along the River *Dee*, which from thence empties it self into the *W. N. W.* where the Sun then was, I concluded this secondary Arch *AFHGC*, was produced by the Beams of the Sun reflected from that Water, which at that time was very calm; and it had been much more bright, had it been at that time about high, as it was low Water, when all the Sands were bare. I was soon confirmed that my Supposition was right, and that it answered all the Appearance without any Scruple, and that the Arch *AFHGC*, was no other than that Part of the Circle of the *Iris*, that would have been under the Earth, bent upwards by Reflection.

I remember not to have read of any such *Iris* in any Author. *Des Cartes* indeed speaks of an inverted *Iris* by *Reflection*, but it is not possible to be seen as he describes it: And I query whether ever any such has been really observed.

LXVII. The Observation of the *Halo*, which appeared at *Paris*, May 12. 1667, engaged *M. Hugen* to propose to the Academy there, what he had meditated some Years before, not only of these *Halo's*, but also of the *Parhelias*. As for *Halo's*, he said, that they were formed by small round Grains made up of two Parts, one transparent, the other opaque; the latter being inclosed in the former, as a Cherry-stone is in a Cherry. Thus *AA*, represents one of these Grains, and *B*, the *Kernel* or opaque Part. *The Causes of Halo's and Parhelias, consider'd, by M. Hugen, n. 60. p. 1066. Vide supra, s. LXIV.*

He related the Observations of those who have seen *Hail* formed after this *Fig. 34.* Manner, and explain'd how that some of these little Grains, which swim up and down in the Air betwixt us and the Sun, being less distant from the Axis, which extends it self from the Sun to our Eye, than of a certain Angle, do necessarily hinder the Rays which fall on them from coming to our Eyes, in Regard that the opaque *Kernel* is the Cause that there is behind every such Grain a Space of a *Conical Figure*, as *MNO* in which the Eye of the Spectator being situated, cannot see the Sun through that Grain, tho' it may see him when posted elsewhere, as some where in *P*.

And to make the Company the more distinctly to understand the Effect which these Grains suspended in the Air must produce, he drew the 35 *Fig.* in *Fig. 35.* which *B*, is the place of the Eye; *BA*, the *Axis* which passeth from the Eye

to the Sun: *C, M, F*, some of the *Icy Grains* with their *Kernel*, making them half Opaque: Among which the *Grain C*, being in the Axis, *BA*, and the Lines *CK, LH*, representing the Rays of the *Sun* nearest to the Axis, the Passage of which is not hindered by the Opacity of the *Kernel*, it is certain, not only the *Grain C*, will not be able to transmit any Ray of the Sun towards *B*, but also that, imagining the Superficies of a Cone, whose Top is in the Eye, and its Sides *BD, BE*, parallel to the Rays *CK, LH*; all the *Grains MM*, which this Superficies shall comprize, will likewise not suffer any Ray to pass to the Eye, because it must needs be in their *Cone* of Obscurity; but those that shall be without this Superficies, as the *Grains FF*, will let them pass, because the Eye is without their *Cone* of Obscurity. Whence it follows, that the Angle of this *Cone BDE*, is that which determines the Diameter of the *Halo*, which depends from the Proportion, the opaque *Grain* hath to the transparent, in which it is inclosed. For if this Diameter is of 44 *Degrees*, as is observed in most *Halo's*, the Bigness of the opaque *Grain* will be to the Transparent, as 40 to 19. But he said, that this Proportion was not always the same, and that the Diversity of it was the Cause, that sometimes there were seen many *Halo's*, one about the other, all having the Sun for their Center.

He added, That it was easy to know, why these *Halo's* were always of a round Figure, whether the Sun be little or much raised above the Horizon; as also to give a Reason of their Colours, which is the same with that in the triangular *Glass Prisms*; as is evident by the *Tangents A.C.* drawn to the *Grain A*, at the Points, where the Ray *DA*, enters or comes out.

Farther he took notice, That it was also manifest why the Red Colour is in the interior Circumference of the *Halo*, and why the Space, which it taketh in, and chiefly near the most lively colour'd Parts, appears obscurer than the Air about; viz. because it is there, where most Grains are, which transmit no Rays of the *Sun* to our Eyes, and so do nothing but darken the Air, as the Drops of Water when it raineth.

As to the *Arch* of the *Circle*, which above touched the *Halo*, seen May 12. 1667, as also that the Colours were more vivid in this Place, and in that below, than in the rest of the *Circle*; he said, that these Effects did not proceed from the Grains he had been speaking of, but from another Cause, which did also serve for the Production of the *Parbelia*, and the *Circles* which almost always accompany them. Touching which *Circles* and *Parbelia's*, he told the Company, that besides the round and half dark Grains, there were also formed in the Air certain little *Cylinders* of the like Nature: Which being suppos'd to be oblong *Icy Grains*, and roundish at both Ends, having the inner *Kernel* of the same Shape, it was found, that from their different Dispositions all the Appearances of the *Parbelia* and their *Circles* did necessarily follow.

And first, That some of these *Cylinders* being erect, in the Situation which probably they ought to have in being formed there, must appear in the Heavens a great *white Circle*, parallel to the Horizon, passing thro' the Sun, and of near the same Breadth with him; as hath been observed in the *Phenome-*

non of Rome. An. 1629. of which Gassendus and Des Cartes have written, and which is here exhibited.

That this Circle *LKNM*, is caused by the Reflection of the Rays of the Sun Fig. 37. upon the Surface of these *Cylinders*, it being easy to demonstrate, that there are none but those which are raised at the same Angle above the Horizon with that of the height of the Sun, that can reflect his Rays to our Eyes. Whence it manifestly follows, that it must appear white, and throughout of equal Altitude with the Sun it self, and by Consequence parallel to the Horizon. That considering afterwards the Transparency of these perpendicular *Cylinders*, and their opaque *Kernels*, it is easily seen, that those of the white Circle, which are distant from the Sun at a certain Angle, begin to give Passage to his Rays to strike our Eyes in the same Manner as hath been said of the round half dark Grains. That these *Cylinders* are those, which on each side of the Sun make us see a *Parhelion* in the great white Circle, as hath been noted in the Observation of Rome, where they are mark'd with *K* and *N*, and in many others. That these *Parbelia* have commonly luminous Tails, because the *Cylinders*, which follow those first ones that form the *Parbelia*, and which are yet farther distant from the Sun, let also pass his Rays to our Eye; so that these Tails may be 20 Degrees and more in Length. That the same *Parbelia* are always colour'd because they are made by Refraction as the Halo.

That besides, there are two other Images of the Sun generated by these perpendicular *Cylinders*, and so disposed in the great white Circle, that the Spectator turning his Face towards the true Sun, hath them behind him; as in the Roman Observation are the *Parbelia L* and *M*. That these are produced by two Refractions and one Reflection in these *Cylinders*, in the same Manner as the ordinary Rainbow in the Drops of Water, according as M. Des Cartes hath declared: So that the opaque *Kernels* do nothing to the Production of these two Suns, but that they may be sometimes so big as to make them not appear. That according to the Altitude of the Sun, more or less these two *Parbelia* are more or less nigh to one another. That they should appear colour'd as the Rainbow, and that sometimes they have been seen such; but that when they are faint, they may also seem white, even as the Halo's when they are not very bright.

That these same perpendicular *Cylinders* can also produce an Halo about the Sun, by reason of the rounding of their two Ends; which maketh, that being distant from the Sun at a certain Angle, on what Side soever it be, they begin from thence to give Passage to the Rays, transmitting them to the Eyes of the Spectator.

And that these Halo's are probably those, we see almost always pass thro' the two *Parbelia* that are on the Sides of the true Sun, as the Halo *GKNL*, in the Phenomenon of Rome.

That there is yet another Situation of these *Cylinders* very considerable, which is of those that are couchant, so as their Axes are parallel to the Plane of the Horizon, but turned divers Ways, some one, some another Way, like Needles confusedly thrown on the Ground: Which Horizontal Disposition is very natural to those *Cylindrick* Bodies supported by the Vapors, which rise from

from the Earth, as may be made out experimentally in Bodies thus figur'd, being let fall in the Air.

That it is in these *Cylinders* that the *Arches* which touch the *Halo's* above or below, are formed; such as there were in the *Phænomenon* observ'd at *Rome A. 1630*, which is described by *P. Shenir* in a Letter to *M. Gassendus*, as also in all those which *M. Hevelius* had related at the End of his *Mercurius in Sole*.

And that the *Arch*, which appeared upon the last *Halo* at *Paris, A. 1667*, was of the same Kind. That the Figure of these *Arches* is different according to the different *Altitudes* of the *Sun*, and the several *Magnitudes* of the *Diameters* of the *Halo's*.

That when the *Sun* is very nigh the *Horizon*, such an *Arch* appearing upon
 Fig. 38. an ordinary *Halo* of 44 *Degrees*, must represent as 'twere two *Horns*, as in Fig. 38. *AB, AC*. But that the *Sun* rising higher, those *Horns* became lower in Proportion, and make such *Arches* as are represented in the same Fig. where each height of the *Sun* is mark'd near the *Arch* which it is to make.

That the place of the *Arches* where they touch the *Halo's* being more strongly enlightned and colour'd than the rest, maketh us judge that there are *Parbelia* in those Places. That the Reason why these *Arches* do ordinarily touch a *Parbelion*, was, that the same *Cylinders couchant*, which produce the *Arch*, produce also that *Parbelion*, by the means of their two round and transparent Ends, in the same Manner as hath been said of the *perpendicular Cylinders*. And that the *Parbelion* last seen at *Paris*, had been form'd in these *couchant Cylinders*. That that was also confirmed, by Reason that it was brighter in the superior and inferior Part than any where else; which necessarily comes to pass in a *Parbelion* caused by *Cylinders* thus disposed, whereas when produced by the *round Grains*, it must appear every where equally strong.

That in these same *Cylinders parallel* to the *Horizon*, there is also found the Cause of the *white Cross*, observ'd together with the *Paraselenes* or *Mock-moons*, by *M. Hevelius*, and exhibited at the end of his *Mercurius in Sole*, the perpendicular Fillet of that Cross coming from the Reflection of the Rays of the Moon upon the Surface of these *Cylinders*; as the other Fillet, parallel to the *Horizon*, is produced by the Reflection of the perpendicular *Cylinders* which make the great white Circle, of which this Fillet is a part. That yet the Moon must not be very high above the *Horizon*, to the end that the couching *Cylinders* may produce this Effect: And that it should be well heeded, when the like *Meteors* shall appear, whether the perpendicular Fillet be not narrower where it passeth through the Moon, than in other places, and especially upwards, where it must grow larger and disappear. That besides the perpendicular *Cylinders*, and those that are couched parallel to the *Horizon*, there are often a great many, which move to and fro in the Air, in all sorts of Positions, and that those, by the same Reason that the round *Grains* do, must produce an *Halo* about the *Sun*, and even a more vivid one than that which is caused by the *Grains*, forasmuch as each *Cylinder* sends many more Rays to the Eye, than each of these little *Spheres*. That the

Fig. 37. little *Halo DEF*, in the *Roman Phænomenon* (Fig. 37.) may very well have been caused by such *Cylinders*.

As to those *Mock-suns*, which sometimes shew themselves directly opposite to the true Sun (such an one as was publish'd by M. *Hevelius*, and observ'd Feb. 23. 1661.) that he could find nothing, neither in the round Grains nor in the Cylinders, which should make these *Suns* necessarily to meet in the great white Circle, parallel to the Horizon; and that if that should be always verified by future Observations, the Cause of it must be look'd for elsewhere: But that in the mean time he did believe, that that happened not but by Chance; which being so, a Reason might be given of these *Suns*, by the same Supposition, which served also for the *Antihelion*, observed by M. *Hevelius*, Sep. 6. 1661; in which there were two colour'd Arches of a Circle, opposite to the *Sun*, which did intersect one another, their Intersection being the Place of the false Sun. Which although it be represented in the Figure of *Hevelius*, at the same Height with the true Sun, yet it was in Truth higher by 15 Degrees or more; as he hath acknowledged himself afterwards: So that, if there had been a great white Circle in this *Phænomenon*, the *Parhelion* was not at all to have been in it.

That for the Generation of these *Suns*, he did suppose a Number of small Cylinders with opaque Kernels, as the precedent, which were carried in the Air, neither perpendicularly nor couching, but inclined to the Plane of the Horizon at a certain Angle, being near a half right one; to which were particularly appropriated those Cylinders, which M. *Des Cartes* saw fall from the Heavens, having Stars at both Ends; as may be seen experimentally by former Cylinders of that Fashion, which is represented in Fig. 39. and letting them descend in the Air, or in Water. That in these Cylinders was found, the following *Calculus* to be given in another Treatise of *Parbelias*, not only the Cause of the *Antihelia* made by the Intersection of two Arches as in Fig. 40. but also that of some other extraordinary Arches and Rods, Fig. 40. that are sometimes observed near the *Sun*, of which notwithstanding there could nothing be as yet affirmed with Certainty, for Want of exact and faithful Observations.

To make all these different Effects of the Cylinders manifest to the Eye, M. *Hugens* produced one of Glass, a Foot long, of the Shape of that in Fig. 36. Fig. 36. and for the Kernel opaque in the middle of a Cylinder of Wood, and in the ambient Space filled with Water instead of transparent Ice: Which Cylinder being expos'd to the Sun, and the Eye put in such Places as was requisite, there were successively seen all those Reflections and Refractions, that have been discours'd of. Whence it might be concluded, that a great Number of the like Cylinders, altho' very small in Comparison to that, being found in the Air, and having the several Postures that have been supposed, all the Appearances of the *Parbelia* and their Circles must exactly follow.

It was wish'd, for an entire Confirmation of the Truth of this *Hypothesis*, that some of those small Cylinders could be observed to fall to the Ground, at the time when any *Parbelia* do appear: Which yet he shew'd could not easily be done, because that the Vapours, which then rise from the Earth upwards, and which are the Cause of their Cylindrical Figure, keep them also suspended in the Air. He added, that it was not to be thought strange, that

that such small Grains of Hail were thus kept in the Air by the Vapors, for as much as these, by being rarified and dilated upwards, might have motion enough for this Effect; and that that was much more easy to conceive, than to imagine how these same Vapors could keep suspended a very great and weighty Circle of Ice, such as Mr. *Des Cartes* supposeth to explicate the Cause of *Parhelia's*, and of the great white Circle of the *Roman Phænomenon*.

Optical Af-
fections con-
cerning the
Rainbow; by
Mr. Fr. Li-
nus, n. 117.
p. 386.

LXVIII. 1 Minima quævis pluviae guttula radiis *Solaribus* illustrata, mittit ex se *Iridem* perfectam, non solum quoad ipsos *Colores*, sed etiam quoad eorum ordinem, situm, ac figuram circularem, ei quam in coelo videmus similimam.

2. Radii enim *Solares* guttulam subintrantes, indeque post duas refractiones & unam reflectionem iterum versus *Solem* redeunt erumpunt è guttula colorati, iisdemque plane coloribus, quos in *Iride* videmus, rubro, flavo, viridi, caeruleo, & purpureo imbuti.

3. Hi radii sic colorati, dum pluvioso Coelo à variis guttulis *Sole* illustratis in oculum transmittuntur, visionem, quam de *Iride* habemus, efficiunt.

4. Dantur autem in qualibet guttula duo *Annuli*, major & minor, distinctis *Coloribus Irialibus* imbuti, quorum minor distat ab Axe seu radio transeunte per centrum guttulæ *Gradibus* circiter 21; major autem ab eodem Axe distat Gr. 78. Radii autem incidentes in minorem *Annulum* inde resiliunt in majorem; e quo erumpentes in Aerem, dictis *Coloribus Irialibus* imbutuntur.

5. Oriuntur igitur hi colores a radiis *Solaribus*; sed non ab iis solis (uti hactenus existimatum) sed etiam a radiis ipsius Aeris, corpus *Solare* ambientis.

6. Sed neque oriuntur hi colores ab omnibus iis radiis, sive *Solaribus*, sive *Aeris*, qui guttulam subintrant; sed ab iis solummodo, qui emittuntur ab ipso limbo *Solari* Aereque ei vicino.

7. Quin & ii radii, qui sic a limbo *Solari* Aereque vicino in guttulam transmittuntur, non omnes spectant ad dictos colores, nec erumpunt colorati; sed illi duntaxat, quorum *Angulus* incidentiæ nec minor est *Gradibus* 45, nec major *Gradibus* 75.

8. A limbo itaque *Solari*, vicinoque *Aere* procedunt colores *Iriales*, non tamen omnes quinque immediate inde fluunt; sed quatuor duntaxat, nempe *Ruber*, *Flavus*, *Cæruleus*, & *Purpureus*: *Viridis* enim oritur ex radiis *Flavis* & *Cæruleis* inter se permixtis.

9. Oriuntur igitur hi quatuor colores a dicto limbo, non tamen omnes ab una eademque ejus parte. Sed duo ex iis ab una parte limbi, & alii duo ab alia ei directe opposita; v. g. a limbo superiore oriuntur *Cæruleus*, & *Purpureus*, & ab inferiore, *Ruber* & *Flavus*.

10. Causa autem, cur a limbis adeo inter se similibus oriantur *Colores* tam dissimiles, non alia hic apparet, quam quod in uno casu limbus *Aerius* sit supra limbum *Solarem*, & in alio limbus *Solaris* sit supra *Aerium*. Hoc autem

Dis-

Discrimen videtur hic sufficere, eo quod, ratione illius diversi situs nunc radii Solares incurventur per refractionem supra radios Aereos, nunc è contra Aerii supra Solares.

11. Oriuntur itaque hi colores per dictos radios refractos, ita tamen refractos ut per eam refractionem valde inter se constipentur. Nam omnes radii a Gradu 45. usque ad 60. ad spatium unius Gradus in minore Annulo contrahuntur: In quod etiam tam angustum spatium confluunt, per retrogradationem, radii omnes a Gradu 60 ad 75.

12. Quando plures homines simul vident Iridem, tot videntur Irides, quot sunt homines videntes.

13. Qui intuetur Iridem, videt singulis momentis aliam & aliam.

LXIX. Iridis Phenomena attente respicientibus semper constabat, Solis radios a nube aquosa reflexos, sub certo quodam Angulo in oculum incurere; unde forma ejus Arcuata; colorum autem causa, ut etiam magnitudinis Anguli istius, quo constanter ab opposito Solis Iridem distare deprehendimus, tam modernos quam veteres diu multumque torfit; nec quicquam profecere, usque dum præclarus ille Cartesius, in auxilium collatis Mathematicis disciplinis, speculationes has physicas strictiori argumentandi methodo tractari posse ac debere, pluribus exemplis edocuit; inter alia vero Iridis theoriā exposuit. Ex hujus demonstrationis constat, Iridem primariam a talibus Solis radiis produci, ubi Excessus duorum Angulorum Refractorum supra unum Incidentiæ Angulum omnium possibilem fuerit maximus: Secundariam vero Iridem formari ab iis radiis tantum, ubi excessus trium Angulorum Refractorum supra unum Incidentiæ Angulum similiter sit omnium maximus. Ac pergere licet ad tertiam, quartamve, vel quamvis aliam Iridem, quæ fiunt, ubi radii, post tres, quatuorve, vel plures reflectiones è guttulis emergunt. In omnibus autem his Regula est generalis, ut excessus quatuor vel quinque vel plurium Angulorum Refractorum (numero scil. Reflectionum unitate aucto) supra unum Incidentiæ Angulum sit omnium maximus. Excessus autem iste maximus duplicatus ubique est distantia Iridis ab opposito Solis, ubi numerus reflectionum impar est: Si vero par sit iste numerus, duplum Anguli istius maximi fit distantia Iridis a Sole ipso.

Ut autem habeantur excessus isti maximi, data liquoris alicujus refractione, five ratione sinus Anguli Incidentiæ ad sinum Anguli refracti, observandum est, Excessum duorum Angulorum refractorum supra unum incidentiæ angulum, maximum fieri, ubi augmentum momentaneum anguli incidentiæ præcise duplum est augmenti momentanei Anguli refracti; trium vero Angulorum refractorum excessum maximum esse, ubi augmentum momentaneum Anguli Incidentiæ triplum est momenti Anguli refracti: & sic de cæteris. Atque hoc per se satis evidens est; Angulos autem ipsos obtinebimus præmissis Lemmate sequente, quod demonstrare oportet.

Lemma. Manentibus cruribus trianguli cujuscvis plani, si augeatur vel minuaturs angulus verticalis angulo quovis dato minore, erunt momenta five mutationes instantaneæ angulorum ad Basim, inter se reciproce ut Segmenta Basis.

Sit ABC Triangulum cujus Vertex A, Crura AB, AC, & Basis BC, in

quam demittatur Perpendicularum AD : Dein augeatur Angulus BAC , Momento aliquo indivisibili CAc , ac ducantur lineæ Bcd , cD , quæ non nisi intellectu differunt a lineis BCD , CD . Dico Momentum Anguli ABC , nempe CBc , esse ad Momentum Anguli ACB , vel ACD , ut CD , ad BD , hoc est reciproce ut Segmenta Basis. Cum enim Angulus ACD , sit summa Angulorum ABC , BAC , Momentum ejus erit etiam summa Momentorum istorum Angulorum sive $CAc + CBc$, sed CAc , æqualis est Angulo CDc , quoniam ab Angulo recto ad D , puncta A , D , Cc , sunt in Arcu Circuli cujus Diameter est AC , per *Euclid.* 3. 9. ac proinde summa Angulorum CBc , CDc , hoc est Angulus DCd , erit Momentum Anguli ACD , vel ACB : Anguli autem isti CBc , DCd , cum minimi sint, sunt inter se ut latera sibi opposita, sive ccD , vel CD , ad BD , hoc est, ut Segmenta Basis reciproce. *Q. E. D.* Quod si Angulus uterque B , & C , fuerit acutus eodem modo demonstrabitur *Lemma* mutatis mutandis.

Corol. Hinc consequitur Momenta Angulorum ad Basim esse inter se, ut sunt Tangentes Angulorum ipsorum directe.

Hoc *Lemmate* muniti facili negotio cujusvis *Iridis Diametrum*, vel Constructione Geometrica vel Calculo, obtinere licet. Exposita enim Linea quavis recta CA , dividatur primum in D , ita ut CA , sit ad CD in ratione *Refractionis*, quæ in aqua fit, ut 250 ad 187, sive accuratius ut 529 ad 396. Deinde dividatur CA , in E , ita ut CE , sit ad AE , ut Unitas ad numerum *Reflectionum*, quas patitur Radius Solis, ad *Iridem* propositam producendam idoneus, ac Diametro AE , describatur Semicirculus ABE , ac Centro C . Radio CD , duc Arcum BD , Semicirculo ABE , in puncto B , occurrentem, Ductis denique rectis CB , AB , demittatur in AB productam Perpendicularis CF , eique parallela EB , dico Angulum CBF , esse Angulum Incidentiæ, ac Angulum CAB , esse Angulum Refractum, quos quærimus, quique producent *Iridem* propositam.

Demonstratio. Cum Triangula ACF , $AE B$, sint similia, erit AF , ad BF , ut AC , ad EC , hoc est ut numerus *Reflectionum* unitate auctus, ad unitatem per Constructionem, ac proinde Momentum Anguli CBF , erit ad Momentum Anguli CAF , in eadem ratione, per *Lemma præcedens*. Sed Sinus Anguli CBF , est ad Sinum Anguli CAF , in ratione Laterum CA , CB , hoc est in ratione *Refractionis* datæ, etiam per Constructionem. Angulus itaque Incidentiæ CBF , habet Angulum refractum, sibi respondentem CAF , eorumque Momenta sunt in ratione proposita, quocirca sunt Anguli quæsitii. *Q. E. D.* Jamque multiplicando Angulum refractum per Numerum *Reflectionum* unitate auctum, & è Facto subducendo Angulum Incidentiæ, habebitur Semissis Distantiæ *Iridis* a Sole, si Numerus *Reflectionum* fuerit par, vel a Solis opposito si fuerit impar; prout jam diximus.

Hinc Constructione satis concinnâ nec ineleganti, omnium ordine *Iridum* Incidentias synopticè exhibere possumus, in quolibet Liquore cujus *Refractionis* cognita est. Si enim Linea exposita AC , dividatur bifariam in E ; trifariam in e , quadrifariam in t , ac quinquifariam in n , &c. ac Diametris AE , Ae , At , An , describantur Semicirculi ABE , $Ab e$, $A\beta t$, $Av n$, Quibus omnibus occurrat Arcus Circularis $DB\beta\beta v$ Centro C , Radio CD , descriptus (qui sit

fit ad AC , in ratione *Refractionis* data) in punctis B, b, β, v ; dico quod ductæ lineæ, $AB, Ab, A\beta, Av$, constituent cum linea AC Angulos $CAB, CAb, CA\beta, CAv$, æquales *Angulis Refractis*, ac cum Radiis $CB, Cb, C\beta, Cv$, respectivè, Angulos æquales *Angulis Incidentiæ* requisitis, nempe ABC , vel potius ejus complementum ad Semi-circulum, pro *primaria Iride*; AbC , pro *secundaria*, $A\beta B$, pro *tertia*, ac AvC , pro *quarta*, & sic deinceps.

Quod si cui Calculo accurato hos Angulos investigare libeat, ex eodem fonte facile eruet Lector *Analysta* quod posito Radius = 1, ac Ratione *Refractionis* ut r , ad s Sinus *Incidentiæ* erit $\sqrt{\frac{4}{3} \frac{1}{r}}$, Sinus vero *Anguli Refracti* $\sqrt{\frac{4}{3} \frac{1}{r}}$ a quibus Angulis provenit *Iris primaria*. Pro *secundaria* vero $\sqrt{\frac{9}{8} \frac{1}{r}}$ erit Sinus *Incidentiæ*, ac Sinus *Anguli Refracti* $\sqrt{\frac{9}{8} \frac{1}{r}}$. Pro *tertia*, Sinus *Incidentiæ* erit $\sqrt{\frac{16}{15} \frac{1}{r}}$. Sinus *Refracti Anguli* $\sqrt{\frac{16}{15} \frac{1}{r}}$. Radii autem Lucis in *Iridem quartam* emergentes in guttulas incidunt cum Angulo cujus Sinus est $\sqrt{\frac{25}{24} \frac{1}{r}}$: Angulus autem *Refractus* Sinum habet $\sqrt{\frac{25}{24} \frac{1}{r}}$. & sic de cæteris. Invenies autem suscepto Calculo admissa Ratione *Cartesiana*, *Iridem primariam* distare ab Opposito Solis $41^\circ. 30'$; *secundariam* $51^\circ. 55'$. ab eodem Opposito; *tertiã* vero $40^\circ. 20'$; ac *quartã* $45^\circ. 33'$. ab ipso Sole; quas nescio an unquam aliquis videre possit ob Lumen Solis in singulis *Reflexionibus* ac *Refractionibus* magis magisque attenuatum. Atque hæc de Magnitudine *Iridum* in Guttulis perspicuis Fluidi, cujus Vires *refractivæ* innotescant, dicta sunt. Restat ut nonnulla adjiciam de Coloribus quibus pinguntur *Irides* eorumque ordine in singulis, variatã scilicet *Refractione* per omnes Gradus possibiles.

Sciendum autem in primis, Lumen omne generis *Cærulei* paulo plus refringi quam Lumen quodvis *Rubens*, à qua differentia oritur Latitudo *Iridum*, observatione quidem ægre definienda, ob incertos Colorum in Nube limites. Quo autem majoris est inæqualitatis Ratio inter CA , & CD , sive quo major est *Refractione* eo major provenit Distantia *Iridis* cujusvis a Sole, adeoque semper *Iridum* limites a Sole remotiores purpureo colore fulgent, propiores vero spisse rubent: Uti semper videre est in *Iride primaria*, quæ quidem evanescit in Opposito Solis, si Sinus *Incidentiæ* fuerit ad Sinum *Anguli Refracti* sicut CA , ad CE sive ut 2, ad 1. Quod si major fuerit Ratio illa, nulla omnino conspici potest *Iris primaria*.

Secundariam autem *Iridem* notandum est in Opposito Solis in punctum abire quoties Ratio *Refractionis* fuerit ut 1, ad 0, 847487—. Inde vero ad Solem ipsum recurrere, ibique evanescere, si dicta Ratio fuerit ut 3 ad 1, sive ut CA , ad Ce . Intermediis vero Rationibus (quales habentur in omnibus Fluidis notis, Aere excepto) quo major est Ratio eo plus distat *Iris* ab Opposito Solis, vel potius a Sole ipso, numerato ultra Semi-circulum Arcu: ac proinde colores diverso a *primaria* ordine reperiri videbuntur in his recursibus, nisi hoc in sensu sumatur distantia *Iridum* a Sole, quod quidem ubique in cæteris observandum.

Vid. Sup.
Vol. I. Cap.
III. § 1

Tertia

Tertia Iris in opposito Solis confunditur, existente ratione refractionis ut 1 ad 0,91855 Indeque ad Solem recurrit in ratione 1, ad 0, 6825. Unde iterum, restituto colorum ordine, in ratione 4, ad 1, five ut CA, ad C, definit in Solis opposito. Iris autem quarta a Sole incipiens in ratione æqualitatis, ad Oppositum ejus transit in ratione 1, ad 0, 94895 indeque ad Solem regreditur, si ratio fuerit ut 5, ad 4. Hinc iterum spargitur ad Solis oppositum in ratione 1, ad 0, 56337 quo spatio clauduntur omnium fluidorum refractiones notæ. Denique ratione existente ut 5, ad 1, five ut CA, ad C, in ipso Sole evanescit; coloribus ubique quoad visum inversis in regressu ad Solem, uti rectis in egressu.

Hinc in nimbis Aqueis, primaria ac quarta Iris coccineos colores Soli objiciunt, secundaria vero ac tertia purpureos.

Unde autem oriatur diversa fluidorum vis refractiva, non levis momenti problema est, interque arcana naturæ nondum sensibus nec ratiociniis nostris objecta merito censendum. Aqua etenim pura, inter fluida omnium minime radios lucis refringit, ac salibus quibuscumque solutis imbuta, secundum quantitatem salis pondusque suum, auget refractiones: ac Spiritus corrosivi, Aqua multo graviores, etiam radios lucis multo plus detorquent; nec mirum quum corpora densiora sint, eoque magis luminis transitus obstruere concipi possunt: Cur autem in spiritibus ardentibus aut Oleis quibuscumque reperiatur tanta refractione, præsertim in Sp. Terebinthinæ aut Vini, cum fluida sint respectu Aquæ admodum levia, ac particulis æthereis plurimum constantia, pari argumento non patet; sed luminis ac materiæ ipsius interiorum cognitionem postulare videtur.

Ex data autem Iridis a Sole distantia refractionis rationem eruere, curiosis an- sam præbet observandi accuratissime ac parvo negotio cujusvis fluidi refractionem: Si enim ab inferiori parte exilis cannulæ vitreæ dependeat guttula alicujus fluidi perspicui, ac Sole prope Horizontem constituto, sed fortiter splendente, observetur, sub quo Angulo cum opposito Solis in guttula conspiciantur Iridis Colores, habebitur levi calculo ratio quæsitæ. Cubica autem est æquatio, unica radice explicabilis, qua ex data Iride primaria supputatur ratio; nempe $T^3 - 3TTt + 4rrt = 0$, ubi T est tangens anguli incidentiæ requisitæ; t autem, tangens semissis distantiae Iridis ab opposito Solis ad radium $r = 1$: Unde juxta Cardani regulas, provenit Theorema. viz. De cubo ipsius t , subducatur productum ex $2tr$ in excessum secantis ejusdem arcus supra radium: differentia erit cubus minor. Eorundem autem summa, adjectis $4trr$ erit cubus major. Summa laterum utriusque cubi atque ipsius t æquabitur Tangenti anguli Incidentiæ, ejusque semis erit etiam Tangens anguli refracti; unde constat ratio quam quærimus.

Hujus rei cape Exemplum. In guttula Olei Terebinthinæ observatur distantia Iridis primariæ ab opposito Solis. $25^\circ. 40'$; quæritur ratio refractionis.

$$t = \text{Tang. } 12^\circ. 50' = 0,227863$$

$$s = \text{Secant. ejusdem} = 1,0256197$$

$$ttt = 0,01182217$$

$$s - r \text{ in } 2tr = 0,01167265$$

+

Diff.

Diff. Cubus minor $0,00014952. \sqrt[3]{0,0530773}$

Summa $0,02349482$

4 trr $0,91122525$

Cubus major $0,93472007 \sqrt[3]{10,9777486}$
 $10,2278063$

$T = \text{Tang. Incid. } 51^\circ. 32' 1,2586322$

$\frac{1}{2} T = \text{Tang. Refr. } 52. 11, 0,6293161$

Denique ut $\sqrt{TT} + 4$, ad $\sqrt{TT} + 1 ::$ ita r , ad $s ::$ ita 1 , ad $0,68026$. Quæ quidem ratio proxime accedit ad illam, quam in *Vitro* ac plurimis Solidis pellucidis experimento inesse constat. *Adamas* autem non tantum duritie ac pretio Diaphana omnia præcellit, sed etiam hac *Vi Refractiva*, cum sit ratio ejus ut 5 , ad 2 , proxime, vel rectius ut 100 ad 41 . Sed de his fortasse suo loco uberius.

Dum in his scribendis occupatus tenerer, meo hortatu peritissimus Geometra, *Dominus de Moivre* similem *æquationem* pro investiganda ratione è data *Iridis secundariæ* semidiametro inquisivit: qua quidem paulo accuratius determinatur ratio, sed cum biquadratica sit, pari facilitate calculus non absolvitur: Hæc autem est $T^4 + \frac{2}{3} T t 2 T T r r - \frac{1}{3} r^4 = 0$. Ubi T , est Tangens *Anguli refracti*; t , Tangens semissis distantiae *Iridis* ab *opposito Solis* ad radium $r=i$. Hæc autem *Æquatio* ejus formæ est, ut semper affirmativa una ac una negativa radice explicari possit, quarum altera ac minor est Tangens *Anguli refracti* in regressu ad *Solem*, viz. cum *purpurei colores Soli* propiores sunt. Major autem radix est Tangens *Anguli refracti*, in *Iride* a *Sole* egrediente, ut supra observavimus; nempe in fluido minoris rationis. In *Oleo Terebinthinæ* observatur distantia hujus *Iridis* ab *opposito Solis* $81^\circ. 30'$; unde eruere potest lector curiosus radices $0, 80822 \dots$ ac $-2, 98, 31 \dots$ Tangentes *Angulorum refractorum*; hinc supputatur ratio majoris inæqualitatis ut 1 , ad $0, 67995 \dots$ qualis est in *Oleo Terebinthinæ*: A majori autem radice provenit ratio minor, ut i , ad $0, 9540 \dots$ proxime, quanta daretur in fluido *Iridem secundariam* ejusdem *Diametri* exhibente, sed quæ *rubentibus coloribus* more *primariæ Solis* respiceret.

LXX. A. 1679. in *Maio*, juxta civitatem *Joukoping* in colle quodam altiori, cui ad spatium quadrantis *Milliaris* subjacet lacus aqua dulci *Wet-ter* dictus, in cujus superficie tum placidissima nulla ventorum vi agitata, repræsentabatur mihi *Insula Wisingsburg*, in eo lacu sita, tam vivide, ut a peritissimo pictore melius vix depingi posset; fenestras enim, & homines, cujus essent sexus, discernere potui; cum tamen ipsa *Insula* in aspectum meum nondum pervenerat, propter interjacentes Colles, & distabat a me per tria *Milliaria* cum quadrante ad minimum, ubi decem *Milliaria Suecica* conficiunt fere unum *Gradum*. Erat tum temporis *Sol* primum ortus, & *Oculus meus* inter locum istum in *Lacu*, ubi hæc repræsentabantur, & *solum*,

A Strange Appearance near Upsal; By Dr. And. Spole. Ph. Col. n. 5. p. 146.

lem; ab hoc loco dum digreditur, nihil tale in Lacu visum est; sicut & altera Die cum ad eundem Locum me contuli eodem tempore, tale quid non comparuit, neque Lacus tanta *Halcyonia erat*.

*An unusual
Meteor; by
Dr. Wallis,
n. 135. p.
368.*

LXXI. Sept 20. 1676. about 7 of the Clock at Night, or soon after, there appeared a sudden *Light*, equal to that of Noon-day; so that the smallest Pin or Straw might be seen lying on the Ground. And above in the Air, was seen (at no great Distance as was supposed) a long Appearance as of *Fire*; like a long Arm (for so it was described to me) with a great Knob at the End of it, shooting along very swiftly: And at its disappearing, seem'd to break into small Sparks or Parcels of *Fire*, like as *Rockets* and such *Artificial Fire-works* in the Air are wont to do. 'Twas so surprising, and of so short Continuance, that it was scarce seen by any who did not then happen to be abroad. I am told by some, that it scarce continued longer than while one might tell 15 or 20 at the most; which will be less than half a Minute. All this might happen well enough from some *fiery Meteor* in our Air; as a *Draco Volans* (as some have been pleased to call this) or the like. But that which makes it the more surprising to me is this, that I find the same to have been seen in most Parts of *England*, and at or near the same time: As, not only at *Oxford* and in *Oxfordshire*, but also in *Northamptonshire*, *Gloucestershire*, *Worcestershire*, *Somersetshire*, *Devonshire*, *Hampshire*, *Sussex*, *Surrey*, *Kent*, *Essex*, and particularly by the Watermen on the *Thames*, in their Passage between *Graves-end* and *London*.

This is a great Breadth of Ground, and too much for any ordinary *Meteor*, in our lower Region of the Air, to be seen in at once; which argues, that either it was higher than it was imagined to be (though the Light of it reached the Earth,) or else, that it had a very swift Motion. This made me then conjecture, that it might be some small Comet, whose *Linea Trajectoria* passed very near our Earth, or upon it: And might, when farther distant from us, appear as a Comet. And that Comet which hath since appeared in *April* and *May* confirms me in the same Opinion; which I conjecture may be the very same which passed by us in *September* last. Why it was not sooner seen, I cannot tell; save what is the common Fate of most Comets, that they are seldom observed till after their nearest Distance from us: And, perhaps, it may have been so near the *Sun* (as to its visible Place) as not to be much above our *Horizon*, save in the day time: And for the like reason it may be, that in *September* last, when it passed by us, it was not more seen abroad in other Parts: it might pass them in the day time, being but in the Twy-light with us, and, had it been one Hour sooner, the Day-light would have hindered us from seeing it. Which way its Motion was when near us, I cannot conclude, so as to satisfy myself. For most that saw it being suddenly surprized, took little more notice of it, than that it suddenly appeared, and was suddenly gone, but saw it so little time as scarce to mark which way. By the Account I had from one in *Northamptonshire* (between *Brackly* and *Banbury*) it should seem to have moved there towards the South-west. By the Account I had from one who saw it in *Hampshire* (between *Winchester* and *Southampton*) it should seem to be

be towards the South-east; from others I have nothing of Certainty, and therefore can conclude nothing. Its Motion might then seem to us the swifter, if its proper Motion were then one Way, and the Earth's Motion here, at the same time, contrary to it. And it is not impossible that its dashing against the Earth might disturb its Motion; as when Clouds in their Passage meet with Mountains.

LXXII. 1. Some Members of the *R. Society* did, with two different sorts of Instruments, make divers Experiments for finding the Proportions of the Compression of Air under Water, in the Month of *July* at *Sheerness*, in the Mouth of the River *Medway*, at the time of high Water, where the Depth was then about 19 Fathom, and the Proportion of the Weight of the *Salt-water* to that of the same Quantity of fresh Water taken out of the River *Thames*, was as 41 to 42.

The Compression of Air under Water, by Mr. — n. 73. p. 2192.

One of the Instruments was a Glass-Bottle that held a Quart of Water, having a brass Ring fastened to the Mouth of it, with a *Valve* or Flap that opened inward, so well fitted, that the Bottle being fill'd more or less with Water, none dropp'd out tho' forcibly shaken. This let down 33 Foot into the Water, the Mouth downwards, and after a little Stay drawn up, was found to be so very near half full of Water, at several Tryals, that it was thought fit to state the Compression of Air at that Depth to that Measure.

The Quantity of *Compression* was known by weighing the Bottle with the Water in it, after that a forcible Depression of the Flap had made way for the Eruption of the compressed Air (which kept it up even when the Bottle was placed with the Mouth upwards,) and then filling the Bottle full of the same Water, and weighing it again; and lastly, by weighing the Bottle after the Water was all let forth; the Weight whereof being deducted, the first Quantity of Water weigh'd just half as much as the second, or so near it that the Fraction was not considerable. Whence it was concluded, that the Quantity of the Air that fill'd the Bottle before it was immersed in the Water, was at the Depth of 33 Feet compressed into half the Space it took up before, and so proportionable at other Depths.

The other Instrument was a Cylinder of Glass, some 2 Foot long, close at one End, and having the other End drawn small with a Lamp, and turn'd down a little way, after the Manner express'd in the *Figure*. This Cylinder was immersed perpendicularly with the crooked End uppermost, by which, as it sunk in the Water, the Pressure thereof did gradually force in so much Water as compressed the Air proportionably to every Depth, till the Cylinder was so far immersed, that the Hole in the crooked Part of it was just 33 Feet under Water; and then it being drawn up by measuring from the Bottom of the Cylinder to the Height of the Hole in the crooked part, by a Pair of Compasses, the Water was found to fill the Cylinder so near the half, that the Motion of the Surface of the Water, and the Minuteness of the Difference being consider'd, it was thought fit to state it to just half.

Fig. 43.

According to these Experiments, confirmed by Tryals at other Depths, the ensuing Table was computed.

The Proportion of the Weight of Salt Water to that of Fresh was found by weighing some Ounces of both in a Bottle, whereof the Weight was exactly known, and which was made with so small a Neck, that the Addition or Diminution of one single Drop in it was discernable.

n. 5. p. 2240. The Table is on these Grounds computed, upon the supposed Depths from the Surface of the Water to the Bottom of the Air included in a Cylinder of 60 Inches, closed at one End, and having the open End downwards.

Depths in Water. Air comprst, to				Depths in Water. Air comprst, to			
Feet.	Fathoms.	Parts.	Inches.	Feet.	Fathoms.	Parts.	Inches.
00	00	1	60	32	0	$\frac{33}{23}$	$30\frac{10}{23}$
1	0	$\frac{1}{4}$	$58\frac{4}{7}$	33	$5\frac{1}{2}$	$\frac{1}{2}$	30
2	0	$\frac{1}{2}$	$56\frac{1}{2}$	66	11	$\frac{1}{2}$	20
3	$\frac{1}{2}$	$\frac{3}{4}$	55	99	$16\frac{1}{2}$	$\frac{1}{4}$	15
4	0	$\frac{1}{2}$	$53\frac{1}{2}$	132	22	$\frac{1}{2}$	12
5	0	$\frac{1}{2}$	$52\frac{1}{2}$	165	$27\frac{1}{2}$	$\frac{1}{2}$	10
6	1	$\frac{1}{2}$	$50\frac{1}{2}$	198	33	$\frac{1}{2}$	$8\frac{1}{2}$
7	0	$\frac{1}{2}$	$49\frac{1}{2}$	231	$38\frac{1}{2}$	$\frac{1}{2}$	$7\frac{1}{2}$
8	0	$\frac{1}{2}$	$48\frac{1}{2}$	264	44	$\frac{1}{2}$	$6\frac{1}{2}$
$8\frac{1}{2}$	0	$\frac{1}{2}$	48	297	$49\frac{1}{2}$	$\frac{1}{2}$	6
9	$1\frac{1}{2}$	$\frac{1}{2}$	$47\frac{1}{2}$	330	55	$\frac{1}{2}$	$5\frac{1}{2}$
10	0	$\frac{1}{2}$	$46\frac{1}{2}$	363	$60\frac{1}{2}$	$\frac{1}{2}$	5
11	0	$\frac{1}{2}$	45	396	66	$\frac{1}{2}$	$4\frac{1}{2}$
12	2	$\frac{1}{2}$	44	429	$71\frac{1}{2}$	$\frac{1}{2}$	$4\frac{1}{2}$
13	0	$\frac{1}{2}$	$43\frac{1}{2}$	462	77	$\frac{1}{2}$	4
14	0	$\frac{1}{2}$	$42\frac{1}{2}$	495	$82\frac{1}{2}$	$\frac{1}{2}$	$3\frac{1}{2}$
15	$2\frac{1}{2}$	$\frac{1}{2}$	$41\frac{1}{2}$	528	88	$\frac{1}{2}$	$3\frac{1}{2}$
16	0	$\frac{1}{2}$	$40\frac{1}{2}$	561	$93\frac{1}{2}$	$\frac{1}{2}$	$3\frac{1}{2}$
$16\frac{1}{2}$	0	$\frac{1}{2}$	40	594	99	$\frac{1}{2}$	$3\frac{1}{2}$
17	0	$\frac{1}{2}$	$39\frac{1}{2}$	627	$104\frac{1}{2}$	$\frac{1}{2}$	3
18	3	$\frac{1}{2}$	$38\frac{1}{2}$	660	110	$\frac{1}{2}$	$2\frac{6}{7}$
19	0	$\frac{1}{2}$	$38\frac{1}{2}$	693	$115\frac{1}{2}$	$\frac{1}{2}$	$2\frac{8}{11}$
20	0	$\frac{1}{2}$	$37\frac{1}{2}$	726	121	$\frac{1}{2}$	$2\frac{14}{23}$
21	$3\frac{1}{2}$	$\frac{1}{2}$	$36\frac{1}{2}$	759	$126\frac{1}{2}$	$\frac{1}{2}$	$2\frac{1}{2}$
22	0	$\frac{1}{2}$	36	792	132	$\frac{1}{2}$	$2\frac{2}{3}$
23	0	$\frac{1}{2}$	$35\frac{1}{2}$	825	$137\frac{1}{2}$	$\frac{1}{2}$	$2\frac{4}{13}$
24	4	$\frac{1}{2}$	$34\frac{1}{2}$	858	143	$\frac{1}{2}$	$2\frac{1}{2}$
25	0	$\frac{1}{2}$	$34\frac{1}{2}$	891	$148\frac{1}{2}$	$\frac{1}{2}$	$2\frac{1}{7}$
26	0	$\frac{1}{2}$	$33\frac{1}{2}$	924	154	$\frac{1}{2}$	$2\frac{2}{9}$
27	$4\frac{1}{2}$	$\frac{1}{2}$	33	957	$159\frac{1}{2}$	$\frac{1}{2}$	2
28	0	$\frac{1}{2}$	$32\frac{1}{2}$	990	165	$\frac{1}{2}$	$1\frac{2}{3}$
29	0	$\frac{1}{2}$	$31\frac{1}{2}$	1023	$170\frac{1}{2}$	$\frac{1}{2}$	$1\frac{2}{3}$
30	5	$\frac{1}{2}$	$31\frac{1}{2}$	1056	176	$\frac{1}{2}$	$1\frac{2}{3}$
31	0	$\frac{1}{2}$	$30\frac{1}{2}$	1089	$181\frac{1}{2}$	$\frac{1}{2}$	$1\frac{1}{7}$

Depths in Water.		Air comprst, to		Depths in Water.		Air comprst, to	
Feet.	Fathoms.	Parts.	Inches.	Feet.	Fathoms.	Parts.	Inches.
1122	187	$\frac{1}{35}$	$1\frac{1}{7}$	1551	$258\frac{1}{2}$	$\frac{1}{48}$	$1\frac{1}{2}$
1155	$192\frac{1}{2}$	$\frac{1}{30}$	$1\frac{1}{2}$	1584	264	$\frac{1}{49}$	$1\frac{1}{2}$
1188	198	$\frac{1}{27}$	$1\frac{1}{3}$	1617	$269\frac{1}{2}$	$\frac{1}{50}$	$1\frac{1}{2}$
1221	$203\frac{1}{2}$	$\frac{1}{24}$	$1\frac{1}{3}$	1650	275	$\frac{1}{51}$	$1\frac{1}{2}$
1254	209	$\frac{1}{22}$	$1\frac{1}{3}$	1683	$280\frac{1}{2}$	$\frac{1}{52}$	$1\frac{1}{2}$
1287	$214\frac{1}{2}$	$\frac{1}{20}$	$1\frac{1}{2}$	1716	286	$\frac{1}{53}$	$1\frac{1}{2}$
1320	220	$\frac{1}{18}$	$1\frac{1}{2}$	1749	$291\frac{1}{2}$	$\frac{1}{54}$	$1\frac{1}{2}$
1353	$225\frac{1}{2}$	$\frac{1}{16}$	$1\frac{1}{2}$	1782	297	$\frac{1}{55}$	$1\frac{1}{2}$
1386	231	$\frac{1}{15}$	$1\frac{1}{2}$	1815	$302\frac{1}{2}$	$\frac{1}{56}$	$1\frac{1}{2}$
1419	$236\frac{1}{2}$	$\frac{1}{14}$	$1\frac{1}{2}$	1848	308	$\frac{1}{57}$	$1\frac{1}{2}$
1452	242	$\frac{1}{13}$	$1\frac{1}{2}$	1881	$313\frac{1}{2}$	$\frac{1}{58}$	$1\frac{1}{2}$
1485	$247\frac{1}{2}$	$\frac{1}{12}$	$1\frac{1}{2}$	1914	319	$\frac{1}{59}$	$1\frac{1}{2}$
1518	253	$\frac{1}{11}$	$1\frac{1}{2}$	1947	$324\frac{1}{2}$	$\frac{1}{60}$	$1\frac{1}{2}$

2. Let ED , represent the *Tube* = x .

AB , the Distance of the upper Part of the *Tube* from the Surface of the Water, above or under it = b .

FC , the Depth of the Water from its Surface to the Bottom of the Air within the *Tube* = a .

CB , that Part of it which remains fill'd with Air, within the Water.

CD , the rest thereof which is full of Water.

And any two of the three first, x , b , and a , being given, the other is known; and consequently the rest also.

For, if by the incumbent Weight of 33 Feet Depth in Water, the Air in the *Tube* is comprst into Half the Space it filled before, then the said 33 Feet Depth of Water equals the Weight, or *Pressure* of the incumbent Air on the Surface of the Water. Now, as the Weight, or *Pressure*, of the Air on the Surface of the Water is to the Depth of the Water, from the Surface thereof to the Bottom of the Air within the *Tube*: So is the Length of the *Tube* fill'd with Air, to the Length thereof filled with Water. That is according to the said Experiments, putting z for 33, or whatever, at other times or places, shall be found to be the Weight, or *Pressure* of the Incumbent Air on the Surface of the Water, (for it is not always the same exactly,) $z : a :: a + b : a^2 \times a + b = CD$.

And therefore $a^2 + ab + za + zb = x$

Wherefore $x - a = b$.

And $bb + zb + zz + zx + b = x = a$

$Dd z$

Therefore

The Calcula-
tion by M—
n. 75. p. 2239.
Fig. 44

Therefore a and b being given, x is known by the *first Equation*; and a and x being given, b is known by the *second*; and b and x being given a is known by the *third*.

The Horizontal Line $BFB AF$, is substituted for $GABEFb$, when the *Close End* of the *Tube* is not even with the Surface of the *Water*, to void the Breach $cC=bB=\frac{1}{2}x b^2$, in the Length of the *Tube*.

Effects of the
varying
Weight of
the Atmos-
phere upon
Bodies Water;
By Mr. Rob.
Boyle, n. 91.
p. 5156.

LXXIII. I caused to be blown at the Flame of a Lamp three small round Glass-Bubbles about the Bigness of Hazel-nuts, and furnished each of them with a short and slender *Stem*, by whose means they were so nicely poised in *Water*, that a very small Change of Weight would make them either emerge if they but lightly leaned on the Bottom of the Vessel, or sink, if they floated on the Top of the *Water*. This being done at a time when the *Atmosphere* was of a convenient Weight, I put them in a wide-mouth'd Glass furnish'd with common *Water*, and leaving them in a quiet Place, where yet they were frequently in my Eye, and were suffered to continue many Weeks (or some Months) I observed, as I expected; that sometimes they would be at the Top of the *Water*, and remain there for divers Days, or perhaps Weeks; and sometimes would fall to the Bottom, and after having continued there for some time (longer or shorter) they would again emerge. And though sometimes (especially if I removed the Vessel that contain'd them to a Southern Window) they would rise to the Top or fall to the Bottom of the *Water*, according as the *Air* was hot or cold; yet 'twas not difficult to distinguish these Motions from those produced by the varying Gravity of the *Atmosphere*. For when the Beams of the Sun, or Heat of the ambient *Air*, by rarefying the *Air* included in the Bubbles, made that *Air* drive out some of the *Water*, and consequently made the whole Bubble (consisting of Glass, *Air* and *Water*) somewhat lighter than a Bulk of *Water* equal to it, though the Bubble did necessarily swim as long as the included *Air* was thus rarefied, yet when the Absence of the Sun, or any other Cause made the *Air* lose its adventitious Warmth, there would ensue a *Condensation* of the *Air* again; and thereupon an Intrusion of more *Water* (to succeed the *Air*) into the Glass, and consequently a sinking of the Bubble, and this would commonly happen at Night, if it did not happen sooner. But when it was upon the Account of the varying Weight of the *Atmosphere* that the Bubbles either rose or fell, it appeared by the *Baroscope*, that the *Atmosphere* was so heavy or so light, that they ought to do so. Insomuch that I divers times predicted, whether I should find the *Mercury* in the *Baroscope* high or low, by observing the Situation and Posture of the Bubbles; and consulting that Instrument, it verified my Conjectures. And though whilst the *Atmosphere* was not too considerably either light or heavy, the Changes of the *Air* as to Heat or Cold, would (as I was saying) place the Bubbles sometimes at the Top, and sometimes at the Bottom of the *Water*, within the Compass of a Day; yet if the *Atmosphere* were either very heavy or very light, the Bubbles would continue at the Bottom or at the Top of the *Water* for many Days together, in Case the *Atmosphere* did not in all that time change its Gravity. And I remember, that I did
for



Fig. 2



Ex-
Re-
away
Air
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477-

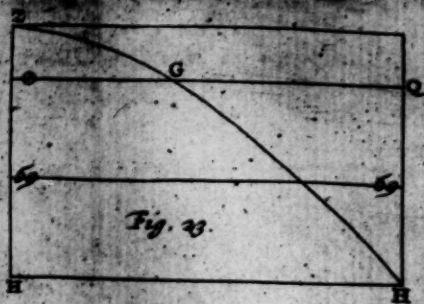


Fig. 23.

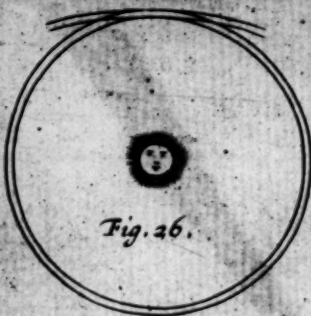


Fig. 26.

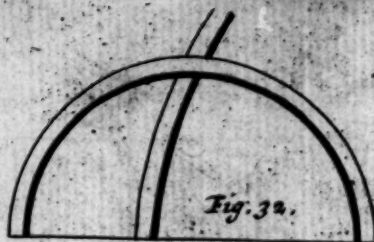


Fig. 32.

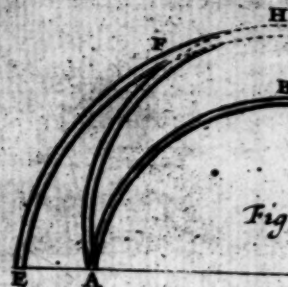


Fig.

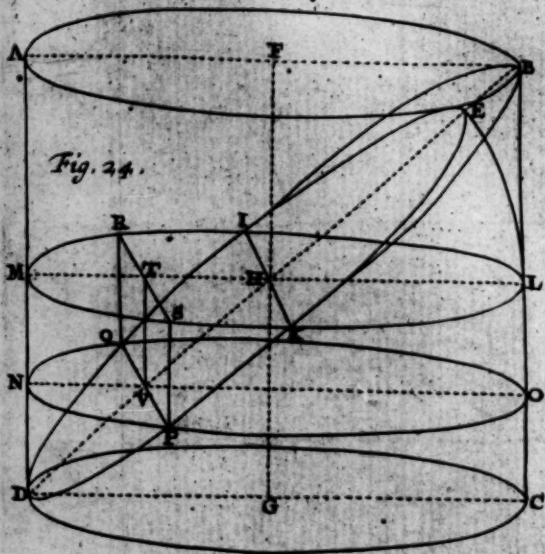


Fig. 24.

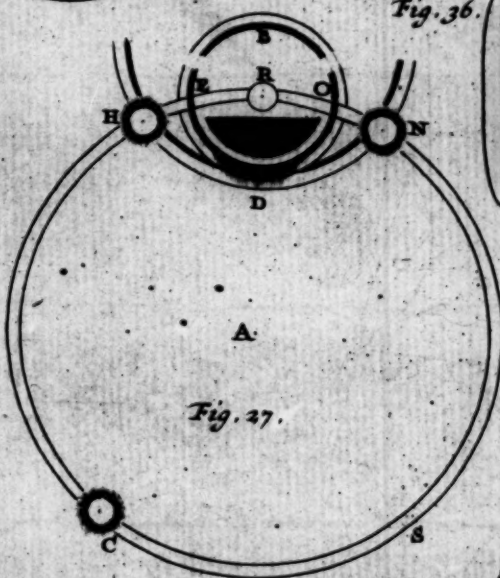


Fig. 27.



Fig. 36.

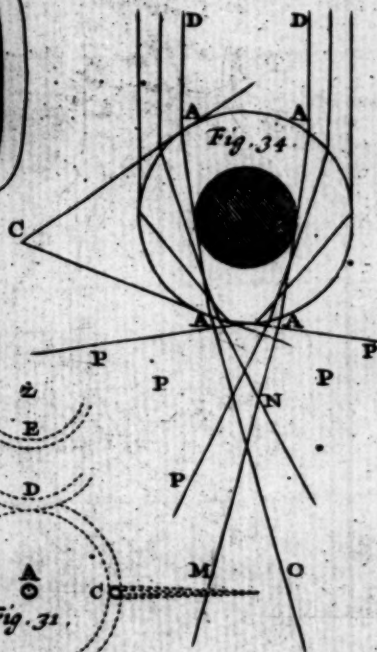


Fig. 34.

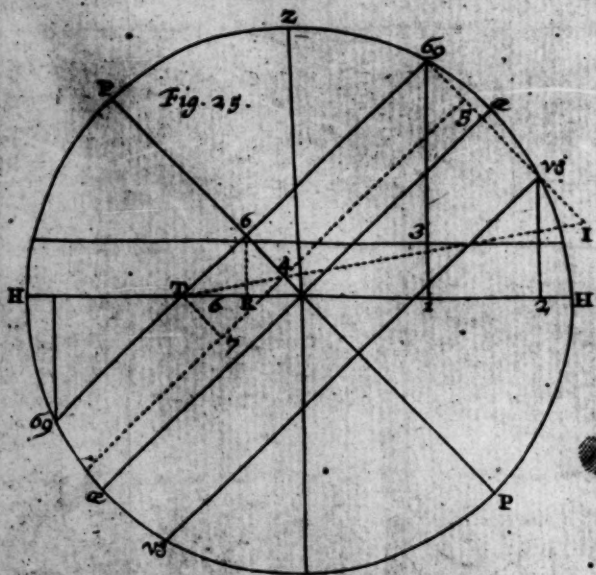


Fig. 25.

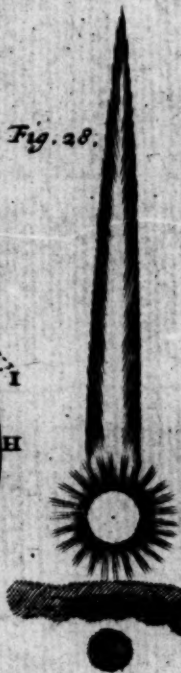


Fig. 28.

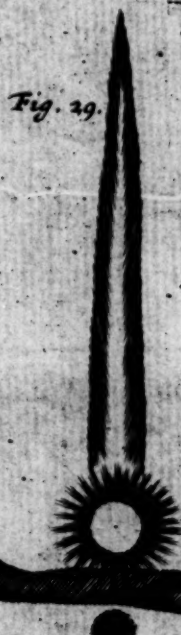


Fig. 29.



Fig. 30.

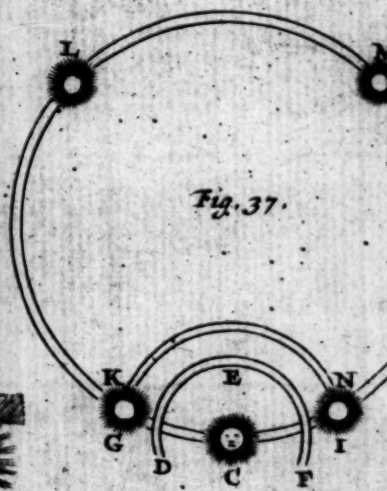
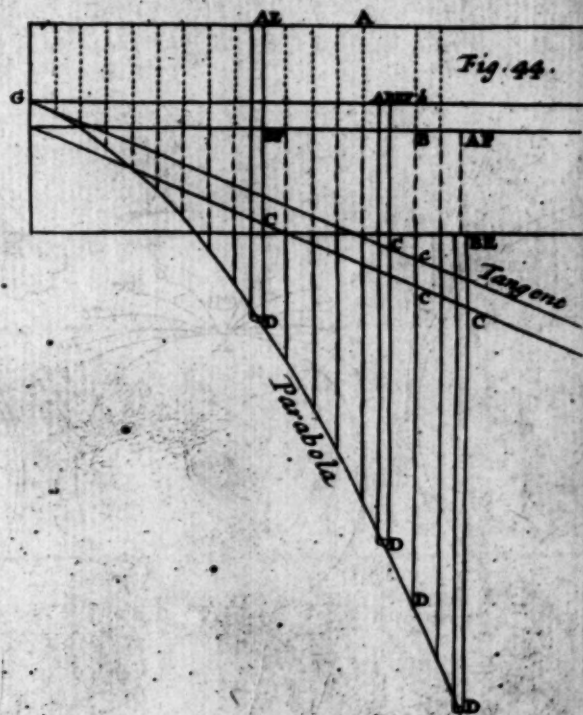
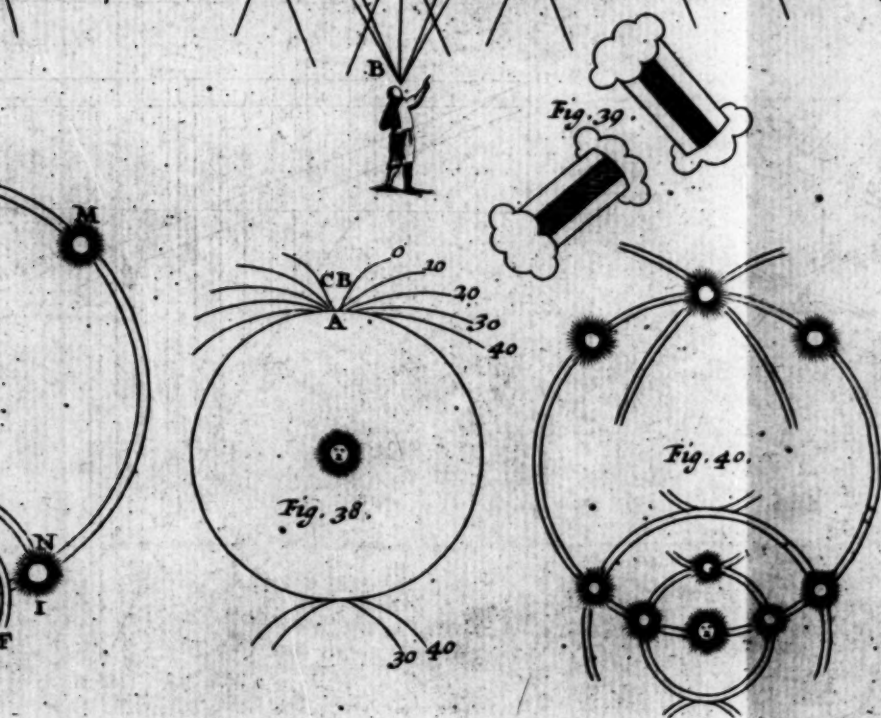
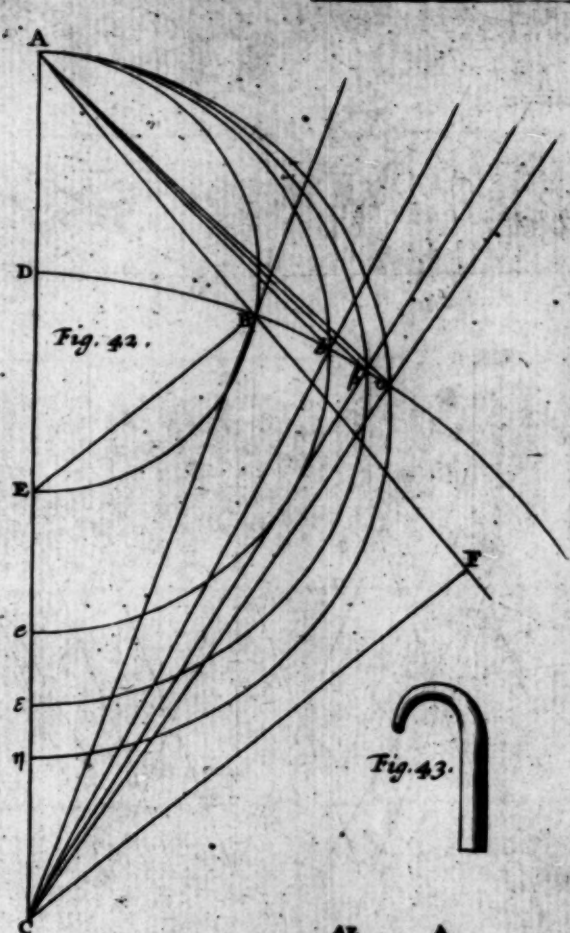
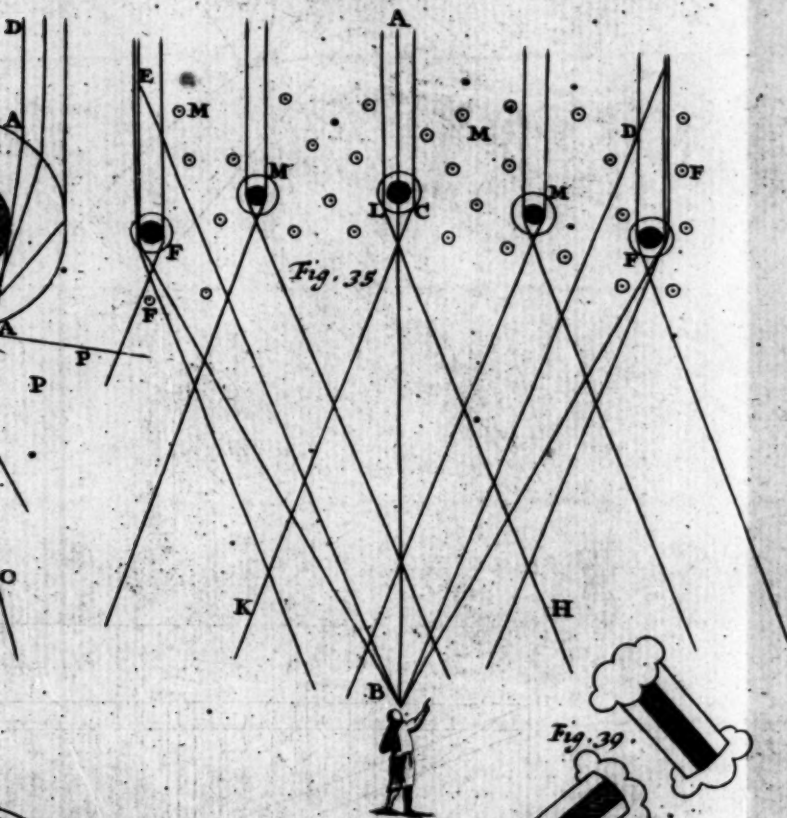
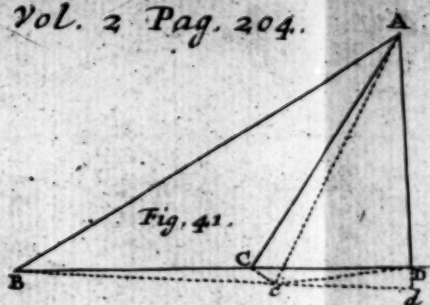
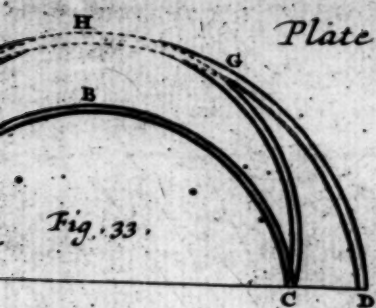


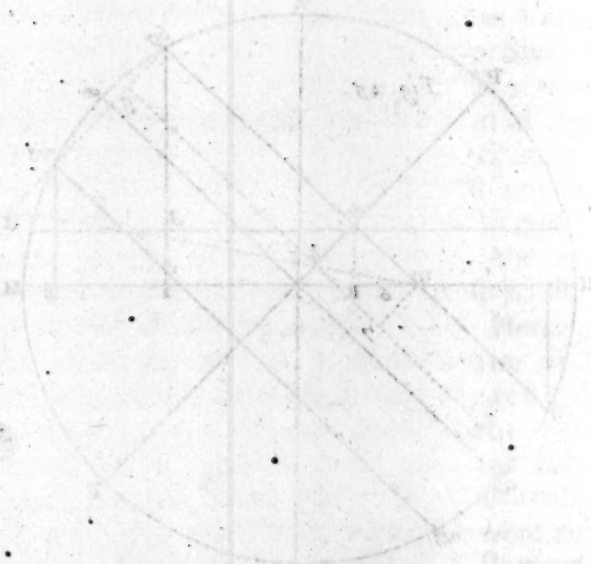
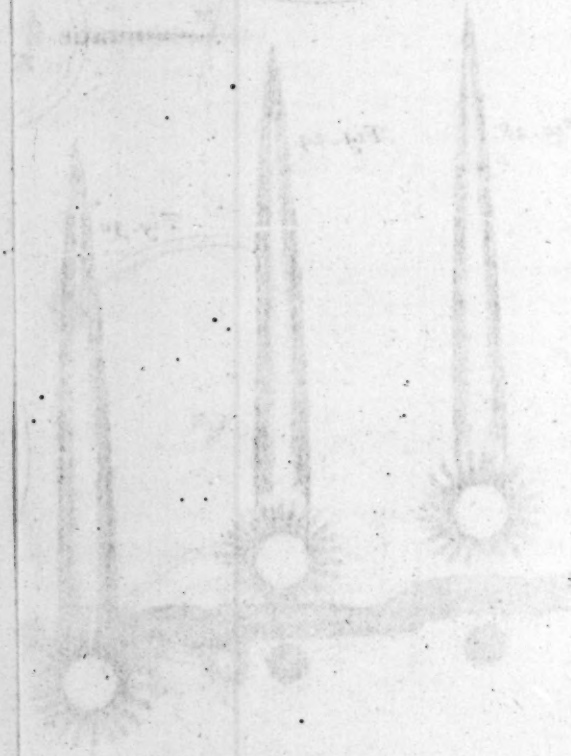
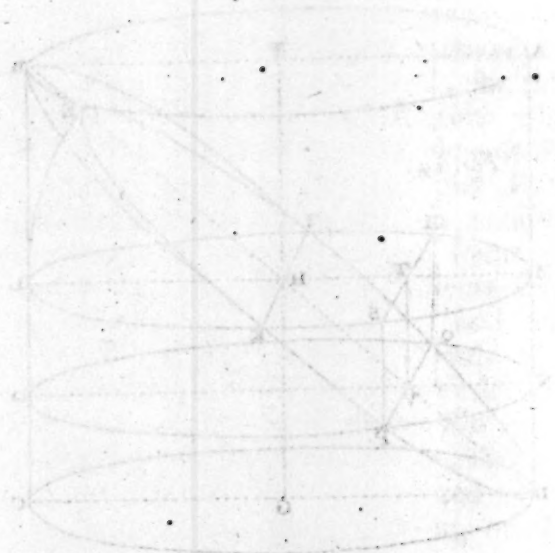
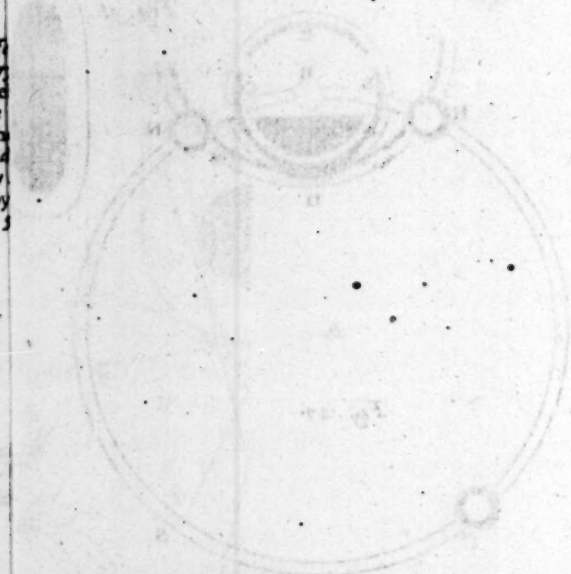
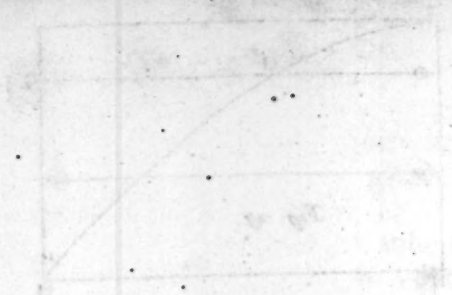
Fig. 37.



Fig. 31.



Eff
var
We
the
sph
Bod
By
Boy
P. 3



for Curiosity's sake, when the Quick-silver was high in the *Baroscope*, put the Glass two or three Days in a South-Window about Noon (and for a good while after) and that in sun-shining Weather, and yet even then the Bubbles did not emerge, though it appeared by a good *seal'd Weather-Glass*, which I kept in the same Window, that the ambient Air was much warmer than at other times, when I had observed the Bubbles to keep at the Top of the Water.

N. B. 1. It being very difficult to *poise* several Bubbles precisely, as well one as another, I thought it not strange that all the three Bubbles did not constantly (though for the most part they did) rise and fall together, but sometimes two of them, and now and then (though seldom) one alone, would sink or emerge, when the Change of the Weight of *Atmosphere* was not considerably enough to operate sensibly upon the rest. And therefore 'tis not amiss to *poise* a great Number of Bubbles together, that after Tryal made of all, the fittest may be chosen. For I have observed it sometimes to happen that a Bubble that floated when 'twas first *poised*, would after a while subside without any manifest Cause, or if it were made to sink by such a Cause, it would continue at the Bottom of the Water, though that Cause were removed; which difficult *Phænomenon* seeming to depend upon a kind of Imbibition made of certain Particles of an aerial Nature by the Water, the Consideration of it belongs to another Place, not to this, where it may suffice, that the Experiment did sometimes actually answer Expectation, as that above related did, wherein my main Drift was to shew, that since, as the *Atmosphere* is heavier or lighter, 'tis capable to work upon Bodies under Water, so as to procure their Sinking, or their Emerision; the Air (though a Fluid a thousand times lighter) must lean or press upon the *Water* it self, by whose Intervention it produces these Effects, which confirms what I elsewhere teach, that the *Atmosphere* is incumbent, as a heavy Body, upon the *terrestrial Globe*.

LXXIV. I caused the Edges of my *Recipient* to be well ground, so as that being apply'd, it every where touched a Glass Plate, which had also been very smoothly ground to serve for a Cover to the same; and I spread a Piece of *Lamb-skin* wetted, over the said Plate, and having thus applied it to the *Engine*, I put my *Recipient* over it: But in one Place there was a Hail-shot of Lead, which kept the *Receiver* from being exactly applied to its Cover, that so the Air might more freely get out. And having afterwards whelmed another great *Receiver* over all, I caused the *Pump* to be plyed. All being well *evacuated*, I shook the *Engine* so as that the little *Receiver* fell off from the Hail-shot, and stood every where close to the Skin, expanded over the Cover of the Glass Plate. Then I had no more to do but to suffer the Air to re-enter into the great *Receiver*, and this Air pressing upon the little one kept it so closely fastened to its Cover, that it was impossible for me to sever them. And I am assured, that the Air enters not into the small *Receiver*, when 'tis thus applied upon the Skin; for I have often put *Gages* in them, which always kept at the same Height, altho' the Air was permitted to re-

To take Ex-
hausted Re-
ceivers away
from the Air
Pump, by
M. Papin, n.
120. P. 477.

n. 121. p.

544.

pass

pass into the great *Receiver*. You might also let alone the putting under of the Hail-shot to keep up the little *Recipient*, because the *Air* by its *Spring* would lift it up sufficiently; but then the *Vacuum* would not be so perfectly made.

When I first began to keep *Receivers* thus void of *Air*, I apply'd *Eel's-Skins* to the Cover. But I found them not proper for Things that are intended to be conserved a long Time, because by drying they grow *springy*, and this *Spring* is capable to raise the whole Pillar of *Air* that presses the *Receiver* against its Cover; and so the *Air* gets in between, and fills the place exhausted.

Afterwards I employed *Mutton-Skins*; but that sticks yet less close than an *Eel-Skin*: For, as soon as the external *Air* comes to press upon it, it makes all the *Water*, which wetterh the Skin, that stands over without, enter into the emptied *Receiver*; and you may see little Drops of *Water* coming out of the Pores of the Skin that is under the *Receiver*; and after the *Water* is all entred, the *Air* quickly gets in the same Way.

At length I took a *Lamb-Skin*, and by means thereof I have kept *Receivers* empty 8 Days together, and never perceived it fail. Yet, for greater security, I do put *Turpentine* round about such *Receivers* as I mean to keep staunch a long Time. Mean while, this Difference betwixt the Skins of *Mutton* and *Lambs* is somewhat remarkable, and confirms what *Physicians* say of the different Constitution of Bodies in *Youth* and *Old-Age*. I afterwards found that Paper wetted serves as well as a *Lamb-Skin*; but you must put *Turpentine* about it before it be dry.

Seeds Sown
in the Ex-
hausted Re-
ceiver; By
... n. 23.
p. 425.

LXXV. Some *Lettice-Seed* being sown upon some Earth in the open Air, and some of the same Seed at the same time upon other Earth in a Glass *Receiver* of the *Pneumatick Engine*, afterwards exhausted of *Air*, the Seed exposed to the *Air* was grown up an Inch and a half high, within 8 Days: But that in the exhausted *Receiver*, not at all. And, *Air* being again admitted into the said emptied *Receiver*, to see whether any of the Seed would then come up, it was found, that in the Space of one Week it was grown up to the height of two or three Inches.

Experiments
concerning
the Relation
between
Light and
Air (in Shin-
ning Wood
and Fish;)
By Mr. Rob.
Boyl, n. 31.
p. 581.

LXXVI. *Exp. I.* Oct. 29th, 1687. Having procured a Piece of shining Wood, about the bigness of a Groat or less, that gave a vivid Light, (for rotten Wood) we put it into a middle-sized *Receiver*, so as it was kept from touching the Cement; and the *Pump* being set a-work, we observed not, during the 5 or 6 first Exfuctions of the *Air*, that the Splendor of the included Wood was manifestly lessened (though it was never at all increased;) but about the 7th Suck, it seem'd to grow a little more dim, and afterwards answered our Expectation, by losing of its Light more and more, as the *Air* was still farther pumped out; till at length about the 10th Exfuction, (though by the removal of the Candles out of the Room, and by black Cloaths and Hats we made the place as dark as we could, yet) we could not perceive any Light at all to proceed from the Wood.

Exp. II. Wherefore we let in the outward *Air* by Degrees, and had the pleasure

pleasure to see the seemingly extinguish'd Light revive so fast and perfectly, that it looked to us all almost like a little Flash of Lightning, and the Splendor of the Wood seemed rather greater than at all less, than before it was put into the Receiver.

But partly for greater certainty, and partly to enjoy so delightful a Spectacle, we repeated the Experiment with the like Success as at first. Wherefore being desirous to see how soon these Changes might be produced, we included the Wood into a very small Receiver of clear Glass, and found, that in this the Light would begin to grow faint at the second, or at least at the third Exsuction of the Air, and at the 6th or 7th would quite disappear. And we found by a Minute-Watch, that the sending the Candles out of the Room, the pumping out the Air till the Wood would shine no more, the re-admitting of the Air (upon which it would in a trice recover its Light) and the sending in for the Candles to consult the Watch, did in all take up but 6 Minutes.

Exp. III. Having exhausted this new Receiver till the Wood quite disappear'd, we stayed somewhat above a quarter of an Hour in the Dark, without perceiving that the Wood had regained any thing of Light, tho' about the End of this Time, we made the place about it as dark as we could; and then it being too late at Night to protract the Experiment, we let in the Air; upon whose Admission the Wood presently recovered Light enough to be conspicuous at a Distance, though it seemed to be somewhat less vivid than before; which yet may be either a Weakness in my Sight, or an effect of the Steams of the Cements, unfriendly perhaps to the luminousness of the Wood.

The Night following we put in a piece of Wood bigger than the former, this being above an Inch long, and that shone very vigorously; and having by a few Sucks quite deprived it of Light, we left it in the exhausted Receiver for full half an Hour, and then coming into the dark Room again, we found all had not continued so stanch, but that some small Portion of Air had insinuated it self into the Receiver. This we concluded to be but a small Portion of Air, because the Wood was but visible to an attentive Eye. And yet that it was really some Air which was got in, that caused the little glimmering Light which we perceived may appear by this, that it did presently (as we expected) vanish at the first or second Suck; and then the Air being let into the dark Receiver, the included Wood presently shone again as before; tho' I suspected that I discerned some little Diminution of its Brightness; which yet till farther Trials of the like Kind, and for a longer Time have been made, I dare not affirm.

Exp. IV. Having observed on another occasion, That sometimes the Operation, which the withdrawing the Air hath upon a Body included in the Receiver, proves more considerable some Minutes after we have ceased Pumping, than immediately after the Exercise is left off, I imagined, that even in such Cases, where the Light is not made wholly to disappear (tho' it be made almost quite to do so) by the emptying of the *Pneumatical-Glass*, the suffering the Body to remain a while there, though without any Pumping (unless now
and

and then a very little to remove the *Air*, that might have stolen in in the mean time) the remaining Light of the Body might probably be farther impaired, if not reduced quite to vanish. To examine this Conjecture, we put in a Body that was not *Wood*, which had some Parts much more *luminous* than the rest; and having drawn out the *Air*, all the others disappeared, and even the formerly brighter ones shone but faintly, when the *Pneumatical-Glass* seem'd to be exhausted. But keeping the included Body a while in that unfriendly Place, we perceived the Parts that had retained Light, to grow more and more dim, some of them disappearing; and that which was formerly the most conspicuous, being now but just visible to an attentive Eye, and that scarce without Dispute; for if we had not known beforehand, that a shining Matter had been included in the *Receiver*, perhaps we should not have found it out. (And he that had the youngest Eyes in the Company could not at all discern it;) but the *Air* being let in, the Body began to shine again.

Exp. V. The *Rarefaction* or *Expansion* of the *Air*, having so notable an Operation upon our shining *Wood*, I thought it would not be amiss to try what the *Compression* of the *Air* would do to it: For which Purpose we included a Piece of it in such a little Instrument to *compress* as hath been devised and proposed by Mr. *Hook*. But tho' we impell'd the *Air* forcibly enough into the *Glass*, yet by reason of the Thickness requisite in such Glasses, and the Opacity thence arising, we were not able then to determine, whether or no any Change was made in the *Luminousness* of the *Wood*. Which I thought the less strange, because by some *Experiments* purposely devised I had long since observed, That even a great Pressure from a fluid Body, which presseth more uniformly against all the Parts it toucheth of the consistent Body, does work a far less manifest Change even on soft or tender Substances, than one would expect from the Force wherewith it compresseth.

Exp. VI. Thinking fit to try whether a small Quantity of *Air*, without being ventilated or renewed, might not suffice to maintain this cold Fire, tho' it will not that of a live Coal, or a Piece of Match, we caused a Piece of shining *Wood* to be hermetically sealed up in a Pipe of clear and thin *Glass*; but tho' carrying it into the Dark, we found it had quite lost its Light, yet imagining that that might proceed from its having been over-heated (being sealed up in a Pipe not long enough to afford it a due Distance from the Flame of the Lamp we employ'd to seal it) we caused 2 or 3 Pieces of fresh *Wood*, amounting all of them to the Length of about 2 Inches, to be seal'd up in a slender Pipe between 4 or 5 Inches in Length; which being warily done, the *Wood* retained its Light very well, when the Operation was over; and afterwards laying it by my Bed-side, when the Candles were carry'd away out of the Room, I considered it a while before I went to sleep, and found it to shine vividly.

The next Morning when I awaked, tho' the Sun was risen, yet forbearing to draw open the Curtains of my Bed 'till I had look'd upon the seal'd *Glass*, which I had fenced with a Piece of Cloth held between it and the Window, my Eyes having not yet been expos'd to the Day-light, since the Darkness they had been accustomed to during the Night, made me think the

Wood shined brighter than ever. And at Night, after 10 of the Clock, looking on it in a dark Place, it appeared luminous all its length, though not so much as in the Morning.

The Morning after, and the Night after that, the same Wood did likewise manifestly, though not vigorously shine, especially one Piece, whose Light was much more vivid than the Rest: And for ought I know, I might have observed them to shine longer, if one of the sealed Ends of the Glasse had not been accidentally broken.

Exp. VII. I caused a piece of Iron to be forged, whose top was of the Bigness of a Nutmeg; the rest being a Stem of an Inch, or an Inch and a half long, for which we provided a little Candlestick of Tobacco-Pipe Clay, which would not yield any smoak to fill and darken the Receiver. Then having heated the Iron red-hot, and placed it in this Clay, so that the round Part was clearly protuberant, we conveyed it into a *Receiver* of white Glasse, which was so placed, as to keep the sides at as great a distance as we could from the Iron, lest the excessive Heat should (as we much feared it would) break the Glasse. Then sending away the Candles, and making the Room dark, we hastily pumped out the Air, but could not perceive the withdrawing of it had any Operation on the glowing Iron. And though it continued shining long enough to give us an Opportunity to pump out and let in the Air three several Times, yet we could not observe, that the Air had any manifest Operation one Way or other. For though upon the withdrawing of the Air the Iron grew dimmer and dimmer, yet that I attributed to the cooling of it; and the rather because having (to examine the Conjecture) let in two or three Times the Air, when the *Receiver* had been exhausted, there appeared no manifest Increase of Light upon the sudden Admission of it.

Exp. VIII. Some curious Persons would perhaps, if they had been present, have desired to see a Trial made, whether or no a small Piece of *shining Wood*, being so included in the *Receiver* as that the pumping out of the *Air* should have no injurious Operation upon the Body of it, its Light would, upon the withdrawing of the *Air*, be manifestly diminished: This Way I was the less backward to try, because it did not readily occur to my Memory, that by any manifest Experiment it appeared, that a Body more thin than *Air* will or can transmit Light, as well as other Diaphanous Mediums. Wherefore having *hermetically sealed* up a Piece of shining Wood in a slender Pipe, and placed it in a small *Receiver* that was likewise made of clear Glasse, we exhausted it of *Air*, and afterwards let in again that which we had excluded. But by neither of the Operations could we perceive any sensible Decrement or Increase of the Light of the Wood, though by that very Observation it appeared, that the Glasse had been well sealed, since otherwise the included *Air* would have got out of the Pipe into the *Receiver*, and have left the Wood without Light.

Exp. IX. I took an old, but thin Glasse, sealed at one End, whose Shape was pretty cylindrical, and whose Bore was about the Bigness of a Man's little Finger, and whose Length was about a Foot or more. Into this Pipe, near the sealed End, we put a piece of *shining Wood*, wedged in with a piece of Cork to keep it from falling; and having inverted the Nose of it into another Slen-

der Glas, but not cylindrical, wherein was pretty store of Quick-silver, we put them both into a long *Receiver*, shaped almost like a Glas Churn, and having pumped a while, that the *Air* included in the Pipe expanding it self, might depress the Quick-silver, and so make escapes into the *Receiver* as long as we thought fit; we then let in the outward Air, that the *stagnant* Quick-silver might be impelled into the Cavity of the Pipe now freed from much of the Air, to the height requisite for our Purpose.

This done, we plied the Pump again, and observed, that as the Air in the Pipe did by its own Spring expand it self more and more, and grow thinner and thinner, the *shining Wood* grew dimmer and dimmer, till at length it ceased to shine, the internal Air being then got a good way lower than the Surface of the external Quick-silver; whereupon opening the Commerce between the Cavity of the *Receiver*, and the *Atmosphere*, the Quick-silver was driven up again, and consequently the Air above it was restored to its former Density; upon which the rotten Wood also recovered its Light. What the greatest Expansion of this Air was, we could not certainly determine, because the Expansion raised the external Quick-silver so high, as to hinder us to see and measure it: But we guessed, that the Air reached to about a Foot or more from the Top of the Pipe to the Surface of the Quick-silver near the bottom of it. But when that rarified Air was impell'd into its former Dimensions, we measured it, and found, that the upper Part of the Tube, unpossessed by the Quick-silver, was about 3 Inches; and the Wood being about an Inch long, there remained two Inches or somewhat better for the Air. But this Experiment ought to be repeated, when exacter Instruments can be procured.

Exp. X. Thinking it fit to try, as well, whether stinking Fish that shines be of the same Nature, as to *Luminousness*, with rotten Wood that shines too; as, whether the withdrawing of the Air will extinguish or eclipse the Light of a considerable Bulk of *luminous Matter*, as in the Experiments hitherto made, we found it would do to a small one: We took a Fish that we had kept, and caused to be watched till it was almost all over *luminous*, though much more in the Belly, and some Parts of the Head than elsewhere: And having suspended him in a conveniently shaped *Receiver*, we found him to give so great a Light, that we suspected beforehand that the withdrawing of the Air would hardly have its full Operation upon a Body, whose Bulk was considerable as well as its Light very vivid, and which had many *luminous* Parts retired to a pretty Distance from the Air. Accordingly having exhausted the *Receiver* as much as we were wont, it appeared indeed, especially towards the latter End of the Operation, that the Absence of the Air did considerably lessen, and in some Places eclipse the Light of those Parts that shone less strongly: But the Belly appeared not much less *luminous* than before. Wherefore supposing, that upon the turning of the *Stcock*, the Air coming in much more hastily than it could be drawn out, we should have the best Advantage to discern, what Interest it had in the *Luminousness* of the Fish, we re-admitted it: And upon its rushing in, perceived the Light to be as it were revived and encreased; those Parts of the Fish

that were scarce visible before, or shone but dimly receiving presently their former Splendor.

And not to leave unprosecuted the remaining Part of the Experiment, which was to try, whether it was the Kind of the *luminous Body* or only the Greatness of the *Bulk*, and the *Vividness* of *Light*, and, if I may so speak, the Tenacity of the Substance it resided in, that made the Difference between the *Fish* and *Wood*; we put Part of a Fish of another Kind, that shone much more faintly than that hitherto spoken of, and but in some Places; and by the withdrawing the Air, we made some of the luminous Parts disappear, and the others so dim, as scarce to be discerned, and yet both the one and the other regained their former Light upon the return of the Air.

And to pursue the Experiment a little farther, we put in such a Piece of the first Fish, as though it were bright, was yet but thin, and not considerably great, and upon pumping out the Air, we found it, according to our Expectation, quite eclipsed, though it recovered its Light upon the Air's Re-entry.

'Tis probable that some will make use of this Discourse to countenance their Opinion, That notwithstanding the Coldness (at least as to Sense) of Fishes and other Animals, there may be in the Heart and Blood a vital Kind of Fire which needs Air, as well as those Fires which are sensibly hot: Which may lessen the Wonder, that Animals should not be able to live when robb'd of Air.

Exp. XI. To examine the Conjecture mentioned in the last Experiment, That the durableness of the Light in the shining Fish, in spite of the withdrawing the Air, might proceed in great Part from the *Vividness* of it, and the Beauty of the Matter it resided in, rather than from the Extent of the luminous Body, in Comparison of the small Pieces of shining Wood, I hitherto had made my Trials with; in Dec. 1667, I got a large Piece of Wood, whose luminous Superficies might be perhaps 10 or 12 Times as great as that which the Eye saw at once of the Surface of such Fragments of shining Wood as I was wont to employ: And though some Parts of this large Superficies shined vividly enough (for rotten Wood; for the Light was usually inferior to that of our Fish) yet this great Piece being put into a convenient Receiver, was, upon the withdrawing of the Air, deprived of Light, as the smaller ones had been formerly; the returning Air restoring its Light to the one, as it had done to the other.

Exp. XII. I took some small Pieces of rotten Fish, that shone some of them more faintly, and some of them more vividly, in Reference to one another, but none as strongly as some that I could have employed; and having in a very small and clear Receiver so far drawn off the Air, as to make the included Body disappear, we so ordered the Matter, that we kept out the Air for about 24 Hours; and then allowing the Air to re-enter in a dark Place, and late at Night, upon its first Admittance the Fish regained its Light.

Exp. XIII. This compared with some of my former Observations about Putrefaction, puts me upon a Trial, which, tho' it miscarried, I shall here
E c 2 make

make mention of, that in case you, who are better furnished with Glasses, think it worth while, you may get reiterated by the Society's Operator; considering how great an Interest *Putrefaction* hath in the *shining* of *Fishes*, and *Air* in the *Phænomena* of *Putrefaction*. I thought it might be somewhat to the Purpose, to take a *Fish*, that was, according to the common Course I had observed in Animals, not far from the State, at which it would begin to *shine*; and having cut out a piece of it, I caused the rest to be hung up again in a Cellar, and the expected Piece to be put into a small and transparent Receiver, that we might observe, if a Day or two, or more, after the *Fish* in the Cellar should begin to shine, that in the exhausted Receiver would either also shine, or, (because that seem'd not likely) would, notwithstanding the Check which the Absence of the Air might be presumed to give the *Putrefaction*, be found to shine too, either immediately upon the Admission of the Air, or not long after it.

But this *Experiment*, was only designed and attempted, not compleated; the *Receiver* being so thin, that upon the *Exhaustion* of the internal Air, the Weight of the external broke it, and we could spare another of that Kind from Trials, we were more concerned to make: Notwithstanding which we made one Trial more, which succeeded no better than the former, but miscarried upon a quite different Account, *viz.* Because neither the included Piece of *Fish*, nor the remaining, tho' it were of the same Sort with the *Fishes* I usually employed, would shine at all, tho' kept a pretty while beyond the usual Time, at which such *Fishes* were wont to grow luminous. But that this Paragraph may not be useless to you, I'll take this occasion to give you a couple of Advertisements, that may relate not only to this Experiment, but also more generally to those whether precedent or subsequent, where *shining Fish* are employ'd.

Advertisement I. In the first place then, I will not undertake, that all the Experiments you shall make with rotten *Fish*, shall have just the same Success with these I have related. For, as I elsewhere observed, that the Event of divers other Experiments is not always certain, so I have had occasion to observe the like about *shining* of *Fishes*. And I remember, that having once designed to make Observations about the Light of rotten *Fishes*, and having in order thereunto caused a competent Number of them to be bought, not one of them all would shine; tho' they were bought by the same Person I was wont to employ, and hung up in the same Place where I use to have them put, and kept not only till they began to putrefy, but beyond the Time that others used to continue to shine: Altho' a Parcel of the same Kind of *Fishes* bought the Week before, and another of the same Kind, bought not many Days after, *shined* according to Expectation. What the Reason of this Disappointment was, I could not determine, only I remember, that at the Time it happen'd, the Weather was variable, and not without some Days of Frost and Snow.

Adver. II. Notice must also be taken in making Experiments with *shining Fish*, that their *Luminousness* is not wont to continue very many Days. Which Advertisement may be therefore useful, because without it we may be apt some-

sometimes to make Trials, that cannot be soon enough brought to an Issue, and so we may mistake the Loss of Light in the Fish to be a Deprivation of it, caused by the *Experiment*, which indeed is but a Cessation according to the usual Course of Nature.

Ex. XIV. We put a piece of *shining Fish* into a wide-mouth'd Glass, about half fill'd with fair Water, and having plac'd this Glass in a *Receiver*, we exhausted the Air for a good while, to observe, whether when the *Pressure* of the Air was removed, and yet (by Reason of the Water that did before keep the Air from immediately touching the Fish) the Exhaustion of the *Receiver* did not deprive the Fish of that Contact of Air, which it had lost before: Whether, I say, in this Case the Absence of the Air would have the same Influence on the shining Body, as in the former Experiments.

And here, as far as the numerous Bubbles excited in the Water would give us leave to discern it, we could not perceive, that either the Absence or Return of the Air had any great Operation upon the Light of the immersed Body.

I shall here inform you, that tho' when I formerly put together some Notes about luminous Bodies, I confined not my Observations to one or two Sorts of Fishes, yet these Experiments were all of them (except a collateral one or two) made with *Whitings*, which, among the Fishes I have had occasion to take notice of, is (except one sort that I cannot procure) the fittest for such Trials.

Exp. XV. To prosecute the I. and IX. Experiments in one Trial, we took somewhat late at Night a Piece of rotten Fish, which we judged to shine too strongly to be quickly deprived of all its Light, and having put it into a small and clear *Receiver*, we found, as we had foreseen, that the *Light* was much impaired, but nothing near suppressed by the withdrawing of the Air. Wherefore having removed the *Receiver* into a convenient Place, I caus'd it to be brought to me about Midnight, and having made the Place pretty dark, I perceived the included Body to continue to shine more vividly than one would have expected, (and if I mistake not I saw it shining in the Morning whilst it was dark;) but the Night after, coming to look upon it again, its *Light* appeared no more: Notwithstanding which, I made a shift to keep out the Air about 24 Hours longer, and so after 48 Hours in all, we opened the *Receiver* in a dark Place, and presently upon the *Ingress* of the Air, were pleasantly saluted with so vivid an Apparition of Light, that the included Body continued to shine, when carried into a Room, where there was both Fire and Candle, if it were but by a *Hat* skreen'd from the Beams.

Being encouraged, as well as pleased with this Success, we forthwith exhausted the Air once more out of the same *Receiver*, and having kept it about 4 Hours longer, we look'd upon it again in a dark Place, and finding no Appearance of Light, let the Air in upon it, whereby it was made to shine again, and that vigorously enough.

The Suddenness, with which the included Body appear'd to be, as 'twere, *rekindled* upon the first Contact of the Air, revived in me some Suspicions, I have had, about the possible Causes of these *short-liv'd Apparitions of Light*, (for I speak not now of real Lamps found in Tombs, for a Reason to be told

you

you another Time) which disclosing themselves upon Mens coming in, and consequently letting in fresh Air into Vaults, that had been very long close, did soon after vanish.

These Thoughts, as I was saying, occurred to me upon what I had been relating, by Reason of the *sudden Operation* of the fresh Air upon a Body, that but a Minute before disclosed no *Light*. For tho' the *Lights* reported to have been seen in Caves, quickly disappeared, which that of our Fish did not; yet that Difference might possibly proceed from the Tenacity, or some other Disposition of the Matter, wherein the *Luminousness* of the Fish resides: For I remembred that I had more than once observed a certain glimmering and small *Light*, to be produced in a Sort of Bodies, upon putting them out of their former Rest, and taking them into the Air; which sparks would vanish themselves, sometimes within one Minute, sometimes within a few Minutes. But as these Thoughts were but transient Conjectures; so I shall not entertain you any longer about them, but rather contenting my self with the Hint already given, take notice of what may be more certainly deduced from our Experiment, which is, that the Air may have a much greater Interest in divers odd *Phænomena* of Nature, than we are hitherto aware of.

And for Confirmation of our Experiment, I shall add, that having in another *Receiver* eclipsed a Piece of Fish that shone when 'twas put in more *languidly* than divers others we had tried, I kept it about 3 Days and 3 Nights in a *Receiver*; after which I opened it in the Dark, and upon letting in the Air upon this Body, that shined but faintly at first, it immediately recovered its so long suppressed *Light*. And having included another Piece that was yet more faint than this, when it was put into the *Receiver*, and having kept this Piece also 3 Days and 3 Nights in the exhausted Glass, I let in the Air upon it, and notwithstanding the Darkness of the Place, nothing of Life was thereupon revived. But this being little other than I expected from a Body that shined so faintly, when 'twas put into the *Receiver*, and had been kept there so long, I resolved to try whether the Appulse and Contract of the Air would have that Operation after some Time that it had not at first; and accordingly, after having waited a while, I observed the Fish to disclose a *Light*, which tho' but dim, was yet manifest enough.

I shall only add, That having included in small *Receivers* 2 Pieces of rotten *Whitings*, whereof the one, before it was put in, scarce shone so vividly as did the other after the *Receiver* was exhausted; and having ordered the Matter so, that we were able to keep out the Air for some Days, at the End of about 48 Hours, we found, that the more strongly shining Body retained yet a deal of *Light*; but afterwards looking upon them both in a dark Place, we could not perceive in either any Shew of *Light*. Wherefore having let in the Air into that *Receiver*, whereinto the Body that at first shined the faintlier had been put, there did not ensue any glimmering of *Light* for a pretty while; nay, upon the rushing in of the Air into the other Glass, the Body that at first shone so strongly, and that continued to shine so long, shewed no glimmering of *Light*. But within less than a quarter of an Hour we saw a manifest *Light* in the Body last named, and a while after the other also became visible, but by
a *Light*

a Light very dim. The more luminous of these Bodies I observed to retain some Light 24 Hours after; and the hitherto recited Experiment had this peculiar Instance in it, that the 2 *Receivers* were uninterruptedly kept exhausted no less than 4 Days, and as many Nights.

LXXVII. I. 1. We put a full grown Duck into a *Receiver*, whereof she fill'd, by our Gues, a third Part, or somewhat more, but was not able to stand in any easie Posture in it; then pumping out the Air, within the short Space of one Minute, she appeared much discomposed, and between that and the second Minute, her struggling and convulsive Motions increased so much, that her Head also hanging carelessly down; she seemed to be just at the Point of Death: So that it did not appear that, notwithstanding the peculiar Structure of some Vessels about the Heart, which enables these and other Water Birds to continue without Respiration for some Time under the Water, this Duck was able to hold out considerably longer than a Hen, or other Bird not aquatick might have done.

This Duck, being revived upon the Admission of fresh Air, and again shut up in the same *Receiver* with the Air in it, continued five Times as long as before, without appearing any ways discomposed.

2. We conveyed a Duckling, that was not yet callow, into the same *Receiver*, and observ'd, that before the first Minute was quite ended, she gave manifest Tokens of being much disordered, and before a second Minute was expired, several convulsive Motions obliged us to let the Air in upon her, whereby she quickly recover'd.

N. B. When the *Receiver* was pretty well exhausted, she appeared manifestly bigger than before the Air was withdrawn, especially about the Crop, though that was very turgid before. We kept the same Duckling in the same *Receiver* very close, to keep out all external Air, and to keep in the excrementitious Steams of her Body for above 6 Minutes without perceiving her to grow sick upon her Imprisonment.

II. 1. Jan. 1663. We included a Viper in a small *Receiver*, and as we drew *Vipers* out the Air, she began to swell, and afforded us these *Phænomena*.

1. It was a good while after we had left pumping, e'er the Viper began to swell so much as to be forced to gape, which afterwards she did.

2. That she continued, by our Estimate, above $2\frac{1}{2}$ Hours in the exhausted *Receiver*, without giving clear Proof of her being kill'd.

3. That after she was once so swelled, as to be compelled to open her Jaws, she appeared slender and lank again, and yet very soon after appear'd swell'd again, and had her Jaws disjoined as before.

2. We took a Viper, and including her in the greatest Sort of small *Receivers*, we emptied the Glass very carefully, and the Viper mov'd up and down within, as it were to seek for Air, and after a while foamed a little at the Mouth, and left off that Foam sticking to the inside of the Glass. Her Body swelled not considerably, and her Neck less, till a pretty while after we had left pumping; but afterwards the Body and Neck grew prodigiously tumid, and a Blister appeared upon the Back. An Hour and an half after the Exhaustion of the *Receiver* (which we then by Trial found to be

Pneumatical
Experiments:
By Mr. Boyle.
n. 62. p.
2011. Upon
Ducks.

be pretty staunch) the distended Viper did give by Motion manifest Signs of Life; but we observed none afterwards. The Tumor reached to the Neck, but did not seem much to swell the under Chap. Both the Neck and a great Part of the Throat being held betwixt the Eye and the Candle, were transparent enough, where the Scales did not darken them. The Jaws remained mightily opened, and somewhat distorted; the *Epiglottis* with the *Rimula Laryngis* (which remained gaping) was protruded almost to the farther End of the nether Chap. As it were from beneath this *Epiglottis* came the black Tongue, and reached beyond it, but seemed by its posture not to have any Life, and the Mouth also was grown blackish within: But the Air being re-admitted after 23 Hours in all, the Viper's Mouth was presently clos'd, though soon after it was opened again, and continued long so; and scorching or pinching the Tail made a Motion in the whole Body, that argued some Life.

3. April 25. We included an ordinary harmless Snake, together with a Gage, in a pretty portable *Receiver*, which, being exhausted and well secur'd against the *Ingress* of the *Air*, was laid aside in a quiet place, where it continued from 10 or 11 a Clock in the Forenoon, till about 9 the next Morning; and then, though he seem'd to be dead, and gave no Signs of Life upon the shaking of the *Receiver*, yet upon holding the Glas at a convenient Distance from a moderate Fire, he did in a short Time manifest himself to be alive by several Tokens, and even by putting forth his forked Tongue. In that Condition I left him, till the next Day early in the Afternoon; at which Time he was grown past Recovery, and his Jaws, which were formerly shut, gaped exceeding wide, as if they had been stretched open by some external Force.

Frogs.

III. 1. Sept. 9th, 1662. We took a large lusty Frog, and having included her in a small *Receiver*, we drew out the Air, and left her not very much swell'd, and able to move her Throat from Time to Time, though not so fast as when she freely breathed before the Exsuction of the Air. She continued alive about 2 Hours that we took notice of, sometimes removing from the one side of the *Receiver* to the other; but she swell'd more than before, and did not appear by any Motion of her Throat or Thorax to exercise Respiration, but her Head was not very much swell'd, nor her Mouth forced open. After she had remained there somewhat above 3 Hours (for it was not $3\frac{1}{2}$ Hour) perceiving no Sign of Life in her, we let in the *Air* upon her, with which the formerly tumid Body shrunk very much, but seem'd not to have any other Change wrought in it; and though we took her out of the *Receiver*, yet in the free *Air* it self, she continued to appear stark Dead. Nevertheless to see the utmost of the Experiment, having caused her to be laid upon the Grass in a Garden all Night, the next Morning we found her perfectly alive again.

2. Jan. 29th, 1660. About 11 of the Clock in the Forenoon, we put a Frog into a small *Receiver*, containing about $15\frac{1}{4}$ Ounces Troy Weight of *Water*, out of which we had tolerably well drawn the *Air*, (so that when we turned the Cock under *Water*, it sucked in about $13\frac{1}{4}$ Ounces of *Water*;) The Frog con-

tinued in it (the *Receiver* all the while under *Water*) lively enough till about 5 of the Clock in the Afternoon, when it expir'd. The *Frog* at the first seem'd not to be much altered by the *Exsuction* of the *Air*, but continued *breathing* both with her Throat and Lungs.

3. Sept. 6th, 1662. We included into a large *Receiver* a couple of *Frogs* newly taken, the one not above an Inch long, and proportionally slender; the other very large and lusty. Whilst the *Air* was drawing out, the lesser *Frog* skipped up and down very lively, and somewhat to our Wonder, clambered up several Times to the sides of the *Receiver*, insomuch that he sometimes rested himself against the sides of the Glass, when his Body seem'd to be perpendicular to the *Horizon*, if not in a *reclining Posture*. He continued to skip up and down a while after the *Exsuction* of the *Air*, but within a quarter of an Hour (measur'd by a *Minute-Watch*) we perceived him to lye stark dead, with his Belly upwards. The other *Frog* that was very large and strong, tho' he began to swell much upon the withdrawing of the *Air*, and seem'd to be distressed, by his frequently leaping up, after the *Air* was drawn out, which he did not before, yet being as we said very lusty, he held out half an Hour; at which Time the Weight of the outward *Air* broke the *Receiver*, and thereby brought him a Reprieve.

4. Sept. 11. We took a small *Frog*, and having conveyed her into a very small portable *Receiver*, we began to pump out the *Air*. At first she was lively enough, but when the *Air* began to be considerably withdrawn, she appeared to be very much disquieted (leaping sometimes after an odd Manner, as it were to get out of the uneasy Prison) but yet not so, but that after the Operation was ended, and the *Receiver* taken off, the *Frog* was perfectly alive, and continued to appear so (if I am not mistaken) near an Hour, tho' the *Abdomen* was very much, and the *Throat* somewhat extended; this latter Part having also left that wonted panting Motion that is supposed to argue and accompany the *Respiration* of *Frogs*. At the end of about 3 $\frac{1}{4}$ th Hours, after the Removal of the *Receiver* from the *Pump*, the *Air* was let in; whereupon the *Abdomen*, which by that Time was strangely swell'd, did not only subside, but seem'd to have a great Cavity in it, as the *Throat* also proportionally had; which Cavities continued, the *Frog* being gone past all Recovery.

5. Apr. 14. A large *Frog* was conveyed into a plated *Receiver*, and the *Air* being withdrawn, her Body by Degrees was distended. The *Receiver* with the *Gage* were kept under *Water* near 7 Hours; at the End of which I found the *Receiver* staunch, but the *Frog* dead, and exceedingly swelled; upon the letting in of the *Air*, she became more hollow and lank than ever.

IV. Being desirous to try, whether *Animals* that had lately been accustomed to live either without any, or without a full *Respiration*, would not be more difficultly or slowly kill'd by the want of the *Air*, than others, which had been longer used to a free *Respiration*, we took a *Kitling* that had been kitten'd the Day before, and put it into a very small *Receiver* that we guessed to hold about a Pint or less, that it might be the sooner exhausted. Within one *Minute*, or a little more, after the *Air* first began to be withdrawn,

drawn, the little Animal, who in the mean Time had gasped for Life, and had some violent *Convulsions*, lay as Dead, with its Head downwards, and its Tongue out; but upon letting in of the Air, it did in a Trice shew Signs of Life, and being taken out of the *Receiver*, quickly recovered.

Another of the same Litter being put into the same *Receiver*, quickly began, like the other, to have *Convulsions*, after which it lay as dead. But tho' we continued pumping, and could not perceive that the *Engine* leaked more than in the former Experiments; the *Kitling* began to stir again, and after a while had stronger and more general *Convulsions* than before, till at the End of full 6 *Minutes* after the *Exsuction* of the *Air* was begun, the *Animal* seeming quite Dead, was taken out of the Vessel, and lay with its Mouth open, and its Tongue lolling out, without any sensible Breathing and Pulsation; till having ordered it to be pinched, the Pain, or some internal Motion, produced by the external Violence done to it, made it immediately give manifest Signs of Life, tho' there was yet no sensible Motion of the *Heart* or the *Lungs*; but afterwards gaping and fetching its *Breath* in an odd Manner, and with much straining, as I have seen some *Fetus's* do when cut out of the *Womb*, it by little and little, within about a quarter of an Hour, recovered.

Inclosing another *Kitling* kitten'd at the same Time, in the same *Receiver*, we observ'd, that diverse violent *Convulsions*, as it were gasping for Breath, into which it began to fall at the second or third Suck, ended in a seeming Death, within about a Minute and a half. A while after, notwithstanding our continuing to pump, the *Kitling* gave manifest Signs of Life, which was not till it had endured diverse *Convulsions*, as great as those of the first Fit, if not greater. When 7 *Minutes* from the Beginning of the Exhaustion were completed we let in the *Air*, upon which, the little Creature that seem'd stark dead before, made us expect that it might recover; but tho' we took it out of the *Receiver* and put *Aqua-vitæ* into its Mouth, yet it irrecoverably died in our Hands.

By what has been related, it appears, that those Animals continued 3 Times longer in the exhausted *Receiver*, than other Animals of that Bigness would probably have done.

The Air concealed in the Pores of Liquors. V. 1. We put some Water in an open Tube, and suffer'd the *Air latitant* in it to escape in an exhausted *Receiver*, without any Artifice to catch it; by which Trial, the Water did not part with any thing of its Bulk, that made a Diminution sensible to the Eye.

2. A chymical Pipe, seal'd at one End, and 36 *Inches* (or somewhat less) in Length, was fill'd with Water, and inverted into a Glass Vessel, not two *Inches* in Diameter, and but $\frac{1}{4}$ th of an *Inch* or little more in Depth. These Glasses being conveyed into a fit *Receiver*, and the *Air* being leisurely pump'd out, and somewhat slowly re-admitted, the numerous Bubbles that had ascended during the Operation, constituted at the Top an *Aerial Aggregate*, amounting to $\frac{1}{100}$ wanting about an 100 Part of an *Inch*.

3. Presently after another Tube was fill'd again with the same Water, and inverted, and the Water being drawn down to the Surface of the vessel-

led

led Water, and the Air let in again, the Water was impell'd up to the very Top, within a 10th and half a Tenth of an *Inch*.

4. The *Tube* for measuring the *Air* latitant in the Water, was $43\frac{1}{2}$ *Inches* above the Surface of the stagnant Water: The *Air* collected out of the Bubbles at the Top of the Water, was the first Time $\frac{1}{4}$ of an *Inch*, and somewhat better; the second Time we estimated it but $\frac{1}{8}$ and $\frac{1}{16}$. The first Time the Water in the *Pipe* was made to subside full as low as the Surface of the restagnant Water: The second Time, the lowest we made it subside seem'd to be 4 or 5 *Inches* above the Surface of the Water in the open Vessel.

I must here advertise, that the *Air* at the Top of the *Tube* did possess more Room than its Bulk did absolutely require, because it was somewhat defended from the Pressure of the *Atmosphere* by the Weight of the subjacent *Cylinder* of *Water*, which might be about 3 or 4 Foot long.

5. We provided a clear round *Glass*, furnish'd with a *Pipe* or *Stem* of about 9 *Inches* in Length, the globulous Part of the *Glass* being on the outside about $3\frac{1}{2}$ *Inches* in Diameter; the *Pipe* of this *Glass* was within an *Inch* of the Top melted at the Flame of a Lamp, and drawn out for two or three *Inches* as slender as a *Crow's Quill*, that the Decrement of the *Water* upon the Recess of the *Air* harboured in its *Pores*, might, if any should happen, be the more easily observed and estimated. Above this slender Part of the *Pipe*, the *Glass* was of the same Largeness (or near it) with the rest of the *Pipe*, that the *Aerial Bubbles*, ascending thro' the slender Part, might there find Room to break, and so prevent the over-flowing, or loss of any Part of the *Water*.

This Vessel being, not without Difficulty and some Industry, fill'd, till the *Liquor* reached to the Top of the slender Part, where not being uniformly enough drawn out, it was somewhat broader than elsewhere; we conveyed the *Glass*, together with a *Pedestal* for it to rest upon, into a tall *Receiver*, and pumping out the *Air*, there disclosed themselves numerous *Bubbles* ascending nimbly to the upper Part of the *Glass*, where they made a kind of Froth or Foam; but by Reason of the above-mentioned Figuration of the Vessel, they broke at the Top of the slender Part, and so never came to overflow. This done, the *Pump* was suffer'd to rest a while, to give the *Aerial Particles*, lodged in the *Water*, Time to separate themselves and emerge, which when they had done a pretty while, the *Pump* was ply'd again, for fear some *Air* should have stolen into so large a *Receiver*.

These Vicissitudes of *Pumping* and *Resting* lasted for a considerable Time, till at length the *Bubbles* began to be very rare, and we weary of Waiting any longer; soon after which, the external *Air* was let into the *Receiver*, and it appear'd somewhat strange to the Spectators, that notwithstanding so great a Multitude of *Bubbles* as had escaped out of the *Water*, I could not by attentively comparing the Place where the Surface of the *Water* rested at first (to which a Mark had been affix'd) with that where it now stood, I could not, I say, discern the Difference to amount to above, if so much, as an Hair's breadth; and the chief Operator in the Experiment professed, that for his part, he could not perceive any Difference at all.

6. Filling a Glass of the same *Shape*, and much of the same *Bigness*, with *Claret-Wine*, and placing it upon a convenient *Pedestal*, in a tall *Receiver*, we caused some of the Air to be pumped out: Whereupon in a short Time there emerg'd thro' the slender Pipe so very great a Multitude of Bubbles, that were darted as it were upwards, as did not a little both please and surprize the Beholders: But it forced us to go warily to work, for fear the Glass should break, or the *Wine* overflow. Wherefore we seasonably left off pumping, before the *Receiver* was any thing near exhausted, and suffered the Bubbles to get away as they could, till the present Danger was over passed, and then from Time to Time we pumped a little more Air out of the *Receiver*, till we were weary, the withdrawing of a moderate Quantity of Air at a Time sufficing, even at the latter End, to make the Bubbles not only copiously, but very swiftly ascend, (by a *Minute-Watch*) for above a quarter of an Hour together.

Shell-Fishes.

VI. 1. An *Oyster* being put into a very small *Receiver*, and kept in long enough to have successively kill'd three or four Birds or Beasts, &c. Was not thereby kill'd, nor, for ought we could perceive, considerably disturb'd, only at each Suck we perceived, that the Air contain'd between the 2 *Shells* broke out at their Commissure; as we concluded from the Foam which at those Times came forth all round that Commissure. About 24 Hours after, I found that both this and another that had been put into the *Receiver* at the same Time, were alive.

2. We put a pretty large *Craw-Fish* into a pretty large *Receiver*, and found that tho' he had been injur'd by a Fall before he was brought thither, yet he seem'd not to be much incommoded by being included, till the Air was in great Measure pumped out, and then its former Motion presently ceas'd, and he lay as dead; till upon the letting in a little Air into the *Receiver*, he began forthwith to move afresh; and upon the withdrawing the Air again, or presently, as before, became moveless. Having repeated this Trial 2 or 3 Times, we took him out of the *Receiver*, where he appear'd not to have suffer'd any Harm.

3. Having put an *Oyster* into a Vial full of *Water*, before we included it in the *Receiver*, it prov'd so strong as to keep it self close shut, and repress'd the Eruption of the Bubbles that in the other did force open the Shells from Time to Time, and kept in its own Air as long as we had occasion to continue the Trials.

4. Moreover a *Craw-Fish*, that was thought more vigorous, being substituted in the Place of the former *Craw-Fish*, tho' once he seemed to lose his Motion together with the Air, yet afterwards he continued moving in the *Receiver*, in spite of our Pumping.

A Seal Fish.

VII. We took a *Receiver* shap'd almost like a *Bolt-head*, containing by Estimation near a *Pint*, and the globulous Part of it being almost half full of *Water*, we put into it, at the Orifice (which was pretty large) a small *Gudgeon*, about 3 *Inches* long, which when it was in the *Water*, swam nimbly up and down therein. Then having drawn out the Air so well, that we guess'd by a *Gage*, that

that about 19 Parts of 20 or more might be exhausted, we secured our selves that the Regress of the *Air* should not injure our Experiment, about which we observ'd that,

1. The Neck of the Glas being very long, though there appear'd great Store of Bubbles all about the Fish; yet the rest of the Water, notwithstanding the withdrawing of so much *Air* as had been mention'd, emitted no Froth, and but few Bubbles.

2. The Fish both at his Mouth and Gills did, for a great while, discharge such a Quantity of Bubbles as appear'd strange, and for about half an Hour or more, (for much longer I had not Opportunity to watch it) whenever he rested a while, new Bubbles would adhere to many Parts of his Body (as if they were generated there) especially his Fins and Tail: So that he would appear almost beset with *Bubbles*; and if, being excited to swim, he was made to shake them off, he would quickly, upon a little Rest, be beset with new ones as before.

3. Almost all the while, he would gape and move his Gills, as before he was included; though towards the End of the Time that I watch'd, it often happened, that he neither took in, nor emitted any *Aerial* Particles that I could perceive.

4. After a while, he lay almost constantly with his Belly upwards, and yet would in that Posture swim briskly as before.

5. Nay, after a while, he seem'd to be more lively than at first putting in; whether by Reason, that by Discharge of so many Bubbles, which by their Dissension, perhaps, put him to Pain, he found himself relieved, or for some other Cause, I examine not.

6. About an Hour and an half after he had been seal'd up, I found him almost free from Bubbles, and with his Belly upwards, and seeming somewhat tumid, but yet lively as before. But an Hour and a quarter after that, he seem'd to be moveless and somewhat still; yet upon shaking the Glas, observing some faint Signs of Life in him by some languid Motions he attempted to make when excited to them, I opened the *Receiver* under *Water*, to try if that Liquor and Air would recover him; and the external *Water* rushing in, till it had fill'd the vacant Part of the Ball, and the greatest Part of the Stem too, the Fish sunk at the Bottom of it, with a greater Appearance than ever of being alive; in which State after he had continued a pretty while, I made a shift, by the help of the *Water* he swam in, to get him through the Pipe into a *Bason* of *Water*, where he gave more manifest Signs of Life: But yet for some *Hours* lay on one side or other, without being able to swim or lye on his *Belly*, which appeared very much shrunk in, as if something, during the Time of its being seal'd up, had been broken in his *Body*, or his *Belly* had been exceedingly distended, beyond Restitution of its former Tone.

All the while he continued in the *Bason* of *Water*, though he moved his Gills as before he had been seal'd up; yet I could not perceive, that he did, even in his new *Water*, emit, as formerly, any *Bubbles*, though two or three Times I held him by the Tail in the *Air*, and put him into the *Water* again.

again, where at length he grew able to lye constantly upon his Belly, which yet retained much of its former Lankness. He lived in the Bason, 8 or 10 Days, though diverse other *Gudgeons* dy'd there in much fewer Days.

Wounded
Animals.

VIII. 1. *Sept. 12.* A small *Bird*, having the *Abdomen* open'd almost from Flank to Flank, without injuring the *Guts*, was put into a small *Receiver*, and the *Pump* being set a-work, continued for some Time without giving any Signs of Distress: But at the End of about a *Minute* and a *half* from the Beginning of the *Exhaustion*, she began to have *convulsive* Motions in the *Wings*; and though the *Convulsions* were not universal, nor did appear violent, as is usual in other *Birds* from whom the *Air* is withdrawn by the *Engine*, yet at the End of two full *Minutes*, letting in the *Air*, and then taking off the *Receiver*, we found the *Bird* irrecoverable; notwithstanding which, we did not find any notable Alteration in the *Lungs*, and found the *Heart* (or at least the *Auricles* of it) to be yet beating, and so it continued for a while after.

2. We took also a pretty large *Frog*, and having, without violating the *Lungs* or the *Guts*, made two such Incisions in the *Abdomen*, that the two curl'd *Bladders* or *Lobes* of *Lungs* came out almost totally at them, we suspended the *Frog* by the *Legs* in a small *Receiver*, and after we had pump'd out a good Part of the *Air* the Animal struggled very much, and seem'd to be much disorder'd, and when the *Receiver* was well exhausted, she lay still for a while as if she had been Dead, the *Abdomen* and *Thigh* very much swell'd, as if some rarified *Air* or *Vapor* forcibly distended them. But as, when the *Frog* was put in, one of the *Lobes* was almost full, and the other almost shrunk up, so they continued to appear, after the *Receiver* had been exhausted; but upon letting in of the *Air*, not only the *Body* ceased to be tumid, but the Plump *Bladder* appear'd for a while shrunk up as the other, and the *Receiver* being remov'd, the *Frog* presently reviv'd, and quickly began to fill the *Lobe* again with *Air*.

The separated
Hearts of
Cold Animals

IX. 1. The *Heart* of an *Eel* being taken out and laid upon a Plate of *Tin* in a small *Receiver* when we perceived it to beat there, as it had done in the open *Air*, we exhausted the *Vessel*, and saw, that though the *Heart* grew very tumid, and here and there sent forth little *Bubbles*, yet it continued to beat as manifestly as before, and seem'd to do so more swiftly; as we tried by numbering the *Pulsations* it made in a *Minute*, whilst it was in the exhausted *Receiver*, and when we had re-admitted the *Air*, and also when we took it out of the *Glass* and suffered it to continue its Motion in the open *Air*.

2. The *Heart* of another *Eel*, after having been included in a *Receiver*, first exhausted and then accurately secur'd from leaking, though it appear'd very tumid, continued to beat there an *Hour*; after which looking upon it, and finding its Motion very Languid, and almost ceas'd, by breathing a little upon that Part of the *Glass* where the *Heart* was, it quickly regained Motion, which I observ'd a while, and an *Hour* after finding it to seem almost quite gone, I was able to renew it by the Application of a little more Warmth.

At the end of the 3^d *Hour* I could no more excite it by *Warmth*; Wherefore I suffer'd the outward *Air* to rush in, but could not discern, that thereby the *Heart* regained any sensible Motion, though assisted with the *Warmth* of my *Breath* and *Hands*.

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X. A suffi-

X. A sufficient Number of Instances of *Animals* kill'd in the exhausted Re-^{Animals}
ceiver, is to be met with in our other Experiments: And therefore I shall now ^{drowned}
subjoin some Trials, about the Times wherein *Animals* may be kill'd by that want ^{and depriv'd}
of Respiration, which, in those that are drowned, is caused by the *Water*
that suffocates them.

1. *Sept. 10.* A *Green Finch*, having his Legs and Wings tyed to a Weight, was gently let down into a *Glass Body* fill'd with *Water*; and at the end of half a Minute he was found quite Dead.

2. A *Sparrow*, that was lusty and quarrelsome, was let down after the same Manner; but though he seem'd to be under *Water* more vigorous than the other Bird, and continued struggling almost to the very end of half a Minute from the Time of his being totally *Immersed* (during which stay under *Water* there ascended from Time to Time, pretty large *Bubbles* from his Mouth) yet notwithstanding that as soon as ever the half Minute was completed he was drawn up, we found him, to our Wonder, *irrecoverably gone*.

3. A small *Mouse*, being held under *Water* by the Tail, emitted from Time to Time diverse *Aerial Bubbles* out of his Mouth, and at last, as one of the Spectators affirmed he saw, at one of his Eyes. Being taken out at the end of half a Minute and some few Seconds, he yet retained some Motions; but they proved but convulsive ones, which at last ended in *Death*.

4. We took the *Duck* mentioned above and so tyed a considerable ^{Vid. Sup. 2.}
Weight of Lead to her Body, as it did not hinder her Respiration, and yet ^{Exp. 1.}
would be sure to keep her down under *Water*. With this Clog she was put into a Tub full of clear *Water*, under whose Surface she continued about a Minute by my Watch quietly enough, but afterwards began to appear for a while much disturbed; which Fit being over, our not perceiving any Motion in her made us, at the end of the *second Minute*, take her out of the *Water*, to see in what Condition she was, and finding her in a good one, after we had allow'd her some breathing Time to recruit her self with *fresh Air*, we let her down again into the Tub, which in the mean Time had been fill'd with *fresh Water*. After a while, she began, and from Time to Time continued, to emit diverse *Bubbles* at her Beak. There also came out at her Nostrils diverse real *Bubbles* from Time to Time; and when the Animal had continued about *two Minutes* or better under *Water*, she began to struggle very much, and to endeavour either to emerge, or change Postures; the latter of which she had liberty to do, but not the former. After *four Minutes* the *Bubbles* came much more sparingly from her: Then also she began to gape from Time to Time, (which we had not observ'd her to do before) but without emitting *Bubbles*; and so she continued gaping till near the End of the *6th Minute*, at which Time all her Motions, some of which were judged *Convulsive*, and others that had been excited by our rousing her with a *Forceps*, appear'd to cease, and her Head to hang carelessly down as if she were quite Dead. Notwithstanding which, we thought fit for greater Security to continue her under *Water* a full Minute longer, and then finding no Signs of Life we took her out; and being hung by the Heels, and gently press'd in convenient Places, she was made to void a pretty Quantity

Quantity of Water. But all the Means that were used, to recover the Bird to Life, proving ineffectual, we concluded, she had been dead a full Minute before we remov'd her out of the *Water*: So that to sum up the Event of our *Experiment*, even this *Water-Bird* was not able to live in cold *Water*, without taking in *Fresh-Air*, above 6 Minutes.

*Vid. Sup. 1.
Exp. 2.*

5. The *Duckling*, (mentioned above,) having a competent Weight ty'd to her Legs, was let down into a *Tub of Water*. There came out Store of *Bubbles* at her Nostrils, but there seem'd to come out more and greater from a certain place in her Head almost equi-distant from her Eyes, but somewhat less remote from her Neck than they. After much struggling and frequent gaping, she had diverse convulsive Motions, and then let her Head fall down backward, with her Throat upwards. To which moveless Posture she was reduced at the end of the *third Minute*, if not a little sooner; but a while after there appear'd a manifest but tremulous Motion in the two Parts of her Bill, which continued for some Time, but afforded no Circumstances, whereby we could be sure, that they were not convulsive Motions; but these also ceasing upon the end of the *fourth Minute*, the Bird was taken out and found irrecoverable.

From these two Experiments it appears, that tho' *Water-Fowl* (at least *Ducks*) could not in our *Receivers* endure the want of *Air* much longer than other *Birds*; yet by that Contrivance of Nature mention'd about the *Heart*, they are enabled to continue much longer under *Water*.

6. A *Viper* that was kept so many Hours in an *exhausted Receiver* till it was concluded to be stark dead, and to have been so for a good while, was kept all Night in a *Glass-Body* upon a warm digestive Furnace: Whereupon the *Viper* was found, the next Morning, to be very lively. We then put her into a tall *Glass-Body* fitted with a Cork to the Orifice of it, and depressed with Weight, so that she could come at no *Air*. And after she had been duck'd a while, she lay with a very little Motion for a considerable Space of Time. At an *Hour* and a quarter she often put out her black Tongue; at near 4 *Hours* she appear'd much alive, and, as I remember, about that Time also put out her Tongue, swimming all this while, as far as we observ'd, above the *Water*. At the end of about 7 *Hours* or more, she seem'd yet to have some Life in her, her Posture being manifestly changed in the *Glass* from what it was a while before, unless that might proceed from some Difference made in her Body as to Gravity and Levity. Not long after she appear'd quite dead; her Head and Tail hanging down movelessly, and directly towards the Bottom of the Vessel, whilst the middle of the Body floated as much as the above-mentioned Cork would permit it.

I must here take notice, that though some of the above-mentioned Animals seem by the Relations we have given of them, to have been a little sooner destroy'd by *Drowning*, than any we have mentioned were by our *Engine*, yet that is no sure Proof, that *Suffocation* does kill Animals faster than the *Deprivation* of *Air*, they are expos'd to in our *Engine*. For in *Drowning*, that which destroys is applied to its full Vigor at the very first, and all at once: Whereas our *Receivers*, being made for several Purposes, the *Deprivation* of the

the *Air*, that they make cannot be made all at once, but the *Air* must be pump'd out by Degrees; so that till the last the *Receiver* will be but partly emptied. For Confirmation of which I have this to alledge, that, having in the Presence of some *Virtuosi*, provided for the Nonce a very small *Receiver*, wherein yet a *Mouſe* could live ſome Time if the *Air* were left in it, we were able to evacuate it at one Suck, and by that Advantage we were enabled, to the Wonder of the Beholders, to kill the Animal in leſs than half a Minute.

XI. 1. Aug. 16. A *Linnet* being put into a *Receiver*, capable to hold about four Pints and a half of *Water*, the Glaſs was well cloſ'd with Cement and a Cover; but none of the *Air* was drawn out with the *Engine*, or otherwiſe. And though no new *Air* was let in, nor any change made in the imprison'd *Air*, yet the *Bird* continued there 3 Hours without any apparent Approach to *Death*; and though it ſeem'd ſomewhat *Sick*, yet being afterwards taken out it recovered, and liv'd ſeveral Hours.

Animals in rarified Air.
n. 63. p. 2036.

2. Aug. 18. From the above-mentioned *Receiver* about half the *Air* was drawn out, a *Linnet* being then in the Glaſs, and in the rarified *Air* (which appear'd by a *Gage* to continue in that State) the *Bird* lived an Hour and near a quarter before it ſeem'd in Danger of *Death*; after which the *Air* being let in without taking off the *Receiver*, ſhe manifeſtly recover'd, and leaped againſt the ſide of the Glaſs; being taken out into the open *Air* ſhe flew out of my Hand to a pretty Diſtance.

3. Sept. 9. We convey'd into a *Receiver*, capable to hold about $4\frac{1}{2}$ Pints of *Water*, a *Lark*, together with the *Gage*, by the Help whereof we pump'd out of the *Receiver* $\frac{1}{4}$ of the *Air* that was in it before; then heedfully obſerving the *Bird*, we perceived it to pant very much, ſo that a learned Phyſician (from whom I yet diſſented) judg'd theſe Beatings to be *Convulſive*: Having continued thus for a little above a Minute and a half, the *Bird* fell into a true convulſive Motion, that caſt it upon the Back. And although we made great haſte to let in the *Air*, yet before the Expiration of the ſecond Minute, and conſequently in leſs than half a Minute from the Time immediately preceding the *Convulſion*, the *Lark* was gone paſt all Recovery.

4. Preſently after we put into the ſame *Receiver* a *Greenſh*, and having withdrawn the *Air*, till it appear'd by the *Gage* there remained but half, we took notice, that, within a Minute after, ſhe appear'd to be very ſick, and ſhaking her Head, threw againſt the inſide of the Glaſs a certain Subſtance, which I took to be *Vomit*, and which afterwards appear'd ſo; upon this *Evacuation* the *Bird* ſeem'd to recover, and continue pretty well (but not without panting) till about the end of the 4th Minute, at which growing very ſick, ſhe vomited again (ſhaking her Head as at firſt,) but much more unqueſtionably than before, and ſoon after eat up again a little of her *Vomit*: At which Time (whether that contributed to her Recovery or no) ſhe very much recovered. And though ſhe had, in all, three Fits of Vomiting, yet for the laſt 7 or 8 Minutes that we kept her in the *Receiver* ſhe ſeem'd to be much more lively than was expected: Which may in Part be attributed to a little *Air* that by an Accident got in, tho' it were immediately

mediately pump'd out again. At the end of a full *quarter* of an *Hour* from the first Exhaustion of the *Receiver*, the Bird appearing little likely to die in a while, we took her out.

5. *April 12.* A *Viper* was included, together with a *Gage* in a portable *Receiver*, capable to hold $3\frac{1}{2}$ *Pints* of *Water*. The Vessel being exhausted, and secured against the Regress of the *Air*, the imprisoned Animal was observ'd not only to be alive, but nimbly to put out and to draw back its *Tongue*, about 36 *Hours* after it was first shut up. At the end of 60 *Hours*, as I was going to *Bed*, she appear'd very dull and faint, and not likely to live much longer; the next Day after *Dinner*, I found her stark dead, with her mouth open'd to a strange *Wideness*: Wherefore suffering *Water* to be impelled by the outward *Air* into the *Cavity* of the *Receiver*, we found that 4 *Parts* of 5, or rather 5 of 6 of the vesselled *Air* had been pumped out.

Difficult Re-
piration at
the Tops of
Mountains.

6. I shall here add, that, an ecclesiastical Person, who had visited those high *Mountains* of *Armenia*, (on one of which, because of their Height, the Tradition of the Natives will needs have the *Ark* to have rested;) told me, that those *Mountains* were really exceeding high, and that he could not come to the *Top*, (because of the unpassable *Snows*.) And that whilst he was in the upper Part of the *Mountain*, he plainly perceived that he was reduced to fetch his *Breath* much oftner than he was wont, and than he did before he ascended the *Hill* and after he came down from it; and that, having express'd some Wonder to find himself so short winded, the People told him, that it was no more than happen'd to them when they were so high above the *Plain*; it being a common Observation among them. He also told me, that he made the like Observation upon the *Top* of a *Mountain* in the Country of *Sevennes*, in or near the Province of *Languedock*.

A learned Traveller, who was a Person very Curious and Intelligent, told me, that being invited, about the beginning of *September*, to visit a neighbouring *Mountain* that is at least one of the Highest of the *Pyreneans*, which is commonly call'd *Pic de Midi*, they found the *Air* there not so fit for *Respiration* as common *Air*, and were fain to breath shorter and oftner than usual; and because I suspected, that might come from their Motion, I ask'd whether they observ'd it to cease when they came down to the *Bottom* of the *Hill*, which he told me they plainly did; besides that, they staid many *Hours* at the *Top*, too long to continue out of *Breath*.

It is worth farther Inquiry, whether the Sicknes, if not also the Difficulty of Breathing that some have been obnoxious to in the uppermost Parts of *Pariacacha*, and perhaps some other high *Mountains*, may not be imputed, not so precisely to the Thinness and Rarity of the *Air*, in Places so remote from the lowermost Part of the *Atmosphere*, as to exclude certain *Steams* of a peculiar Nature, which in some Places the *Air* may be imbued with? For an intelligent Person inform'd me, that he had attempted to go up to the *Top* of the *Pic* of *Teneriffe*: But that, though some of the Company were able to do so, he and some others, before they had reached near so high, grew so sick upon the Operation they felt of the sharp *Air*, and sulphurous Exhalations which infected it, that they were fain to stay behind their Compani-

on.

ons, he having already found this Effect of those *peircing Steams* upon his Face, that the *Skin* began to be of a *Pale-yellow*, and even his *Hair* to be discoloured.

XII. We included a *Mouſe* in a fine limber and clear *Bladder*, made more transparent by being anointed with *Oyl* on the outside, that the Smell of it might leſs offend him. *Animals in the ſame Air, vary'd as to Density.*

Then, to make up ſo large an Orifice without Wrinkles, (at which the *rarefied Air* may eſcape) we provided a round Stick, ſomewhat leſs than the Orifice, which we laid over with a cloſe and yielding Cement, (for Pitch, or the like uncommon Stuff, will not always ſerve the Turn) and ty'd the *Bladder* faſt and cloſe enough upon it, leaving in the *Bladder* as much *Air* as we thought might ſuffice him for as long Time as the *Experiment* was to laſt. Then putting this Limber or *extenſible Receiver*, if I may ſo call it, into an ordinary one of Glaſs, and placing this *Engine* near a Window, that we might ſee through both of them; the *Air* was by Degrees pumped out of the *external Receiver*, (as for Diſtinction's ſake I ſhall call it,) and thereupon the *Air* included in the *Bladder* did proportionally expand it ſelf, and ſo diſtend the *internal Receiver*, till being arrived at a Degree of *Rarefaction*, which rendred it unfit for the included *Mouſe's* *Respiration*, I perceived, though with ſome Difficulty, in this Animal the Signs of his being in great Danger of *ſudden Death*. Whereupon the outward *Air*, being haſtily let into the *external Receiver*, compreſſed the ſwelled *Bladder* to its former Dimensions, and thereby the included *Air* to its former *Density*, by which means the *fainting Mouſe* was quickly revived. Having given him ſome convenient Time of Reſpite, the *Experiment* was reiterated with the like Succeſs; and we doubted not but the *third Trial* we made, would have ended as the two former did: But that, whiſt we were conſidering of the Sickneſs of the *Mouſe*, which, by Reaſon of ſome Opacity that would ſcarce be avoided in the wrinkled *Bladder*, was not, as to its Degree, ſo eaſily taken notice of, it grew *irrecoverable* by the ſubſequent *Condensation* of the *Air*.

XIII. 1. We took a good Company of *Tadpoles*, and put them with a convenient Quantity of *Water* into a portable *Receiver* of a round Figure, and obſerv'd, that at the firſt *Exſuction* of the *Air*, they did riſe to the Top of the *Water* though moſt of them ſubſided again, till the next *Exſuction* raiſed them. They ſeem'd by their active and wrigling Motion to be very diſcompoſed. The *Receiver* being *exhausted* they continued reſtleſs, moving all of them on the Top of the *Water*, and tho' ſome of them ſeem'd to endeavour to go to the Bottom, and dived ſome Part of the Way, eſpecially with their Heads, yet they were immediately buoyed up again. Within an *Hour* or a little more they were all moveleſs, and lay floating on the *Water*; wherefore I opened the *Receiver*, upon which the *Air* ruſhed in, and almoſt all of them (which were many) preſently ſunk to the Bottom, but none of them recovered to *Life*. *The Production and Growth of Animals in an exhausted Receiver.*

2. A little after theſe, we included a leſſer Number of *Tadpoles* in a ſmaller Glaſs, which was alſo *exhausted* with the like Circumſtances with the former. And when I found the other *Tadpoles* to be *dead* I haſted to theſe which did not, except perhaps one, give any Sign of *Life*, but upon letting in the *Air*, theſe having not been long kept from it, ſome few of them did recover,

ver, and swam up and down lively enough for some Time; though after a while they also dy'd.

3. Some Years after, I repeated the same *Experiment*: And though after the *Exhaustion* was perfected, the *Tadpoles* did for a while move briskly enough on the top of the *Water*, (none of them appearing able to Dive or Swim under *Water*) yet coming to look on them after the End of an *Hour*, they seem'd to be all of them quite dead, yet continued floating. And though within half an *Hour* after that, I let in the *Air* upon them, yet all the Effect of it was, that the most of them immediately sunk to the Bottom, as the rest of them did a very little while after; none of them, that I could observe, recovering any *vital Motion*.

4. Having, after much watching and with much ado got 4 or 5 of those odd *Aquatick Insects* whereof *Gnats* are generated, about the End of *August*, after a Shower of *Rain* which drop'd from a House into a Vessel laid on Purpose for it, we included them, with some of their *Water*, into a small Glass *Receiver*, which being very exactly closed, we kept in a South-Window, where those little Creatures continued to swim up and down for some few *Days*, without seeming to be much incommoded by so unusual an Habitation; and at the End of that Time, and much about the same Day, they divested the Habit they had whilst they lived as *Fishes*, and appear'd with their *Exuvie*, or cast Coats, under their Feet, shewing themselves to be perfect *Gnats*, that stood without sinking upon the Surface of the *Water*, and discovered themselves to be *alive* by their Motion, when they were excited to it: But I could not perceive them to fly in that *thin Medium*; to which Inability, whether the *Viscosity* of the *Water* might contribute, I know not, though they lived a pretty while, till Hunger or Cold destroy'd them.

The Expansion of Blood and other Animal Juices and of the Soft Parts of the Body.

1. The warm *Blood* of a Lamb, or a *Sheep*, being taken as it were hastily brought from the Butchers, where the Fibres had been broken to hinder the *Coagulation*, was in a wide mouth'd Glass put into a *Receiver*, made ready for it; and the *Pump* being early set on Work, the *Air* was diligently drawn out. After a long Expectation, the more subtile Parts of the *Blood* would begin to force their Way through the more clammy ones, and seem to boyl in large Clusters, some as big as great Beans or Nutmegs; and sometimes to the Wonder of the by-standing Physicians, the *Blood* was so volatile, and the Expansion so vehement, that it boyled over the containing Glass; of which, when it was put in, it did not, by our Estimate, fill above a Quarter.

Having also included some *Milk*, warm from the Cow, in a cylindrical Vessel of about 4 or 5 Inches high, when the *external Air* was fully withdrawn, the white Liquor began to boyl in a Way that was not so easie to describe, as pleasant to behold: And this it did for a pretty while, with so much Impetuosity, that it threw up several Parts of it self out of the wide mouthed Glass that contained it (and could have continued as much more) though there were not above two or three Ounces of the Liquor.

A yet greater Disposition to the *Intumescence* we thought we observ'd in the *Gall*, which was but suitable to the *Viscosity* of the Texture.

Note, That

Note, That the two foregoing Experiments were made with an Eye cast upon the Inquiry, that I thought might be made, whether, and how far the destructive Operation of our *Engine* upon the included Animal, might be imputed to this, that upon the withdrawing of the *Air*, besides the Removal of what the *Air*'s Presence contributes to Life, the little *Bubbles* generated upon the Absence of the *Air* in the Blood, Juices, and soft Parts of the Body, may by their vast Number and their conspiring Distensions, variously streighten in some Places, and stretch in others, the Vessels, especially the smaller ones, that convey the Blood and Nourishment: And so by choaking up some Passages, and vitiating the Figure of others, disturb, or hinder the due Circulation of the Blood? Not to mention the Pains that such Distensions may cause in some Nerves and membranous Parts, which by irritating some of them into Convulsions, may hasten the Death of Animals, and destroy them sooner by occasion of that Irritation, than they would be destroyed by the bare Absence, or Loss of what the *Air* is necessary to supply them with. And to shew, how this Production of Bubbles reaches even to very minute Parts of the Body, I shall add on this occasion, (hoping that I have not prevented myself on any other) what may seem somewhat strange, what I once observed in a *Viper*, furiously tortured in our exhausted Receiver, namely, that it had manifestly a conspicuous Bubble moving to and fro in the waterish Humour of one of its Eyes.

2. And to shew, that not only the Blood and Liquors, but also the other soft Parts, even in cold *Animals*, have aerial Particles latent in them, we took the *Liver* and *Heart* of an *Eel*, as also the *Head* and *Body* of another *Fish* of the same Kind, cut asunder cross ways somewhat beneath the *Heart*, and putting them into a *Receiver*, upon the withdrawing of the *Air*, we perceived that the *Liver* did manifestly swell every way, and that both the upper and lower Parts did so likewise; and at the place where the Division had been made there came out, in each Portion of the *Fish*, diverse *Bubbles*, several of which seem'd to come from the *Medulla Spinalis*, or the Cavity of the *Back-bone*, or the adjoining Parts, and the external *Air* being let in, both the Portions of the *Eel* presently shrunk, some of the Skin seeming to be grown empty or flaccid in each of them.

XIV. 1. We included in a round Vial with a wide Neck, (the whole *Glass* being capable of containing about 8 Ounces of *Water*) a young and small *Mouse*, and then tied strongly upon the upper Part of the *Glass*'s Neck a fine thin *Bladder*, out of which the *Air* had been carefully expressed, and then conveyed this phantastical Vessel into a middle siz'd *Receiver*, in which we also plac'd a *mercurial Gage*. The *Air* was by Degrees pumped out, till it appeared by the *Gage* that there remained but a 4th Part in the external *Receiver*, (as for Distinction sake I call it;) whereupon the *Air* in the external *Receiver* expanding it self, appear'd for to have blown the *Bladder* almost half full, and the *Mouse* seem'd very ill at Ease by his leaping, and otherwise endeavouring to pass out at the Neck of his uneasy Prison; we did for fear the over thin *Air* would dispatch him, let the *Air* flow into the external

Assuefaction
to rarified
Air.

external Receiver, whereby the *Bladder* being compress'd, and the *Air* in the *Vial* reduced to its former *Density*, the little Animal quickly recover'd.

2. A while after, without removing the *Bladder*, the *Experiment* was repeated, and the *Air* by the help of the *Gage*, was reduced to its former Degree of *Rarefaction*; and the *Mouse* was kept in that thin *Air* for full 4 *Minutes*; at the End of which he appeared so sick, that to prevent his dying immediately, we remov'd the *external*, and took out the *internal Receiver*. Whereupon, tho' he recovered, yet 'twas not without much Difficulty; being unable to stand any longer upon his Feet, and for a great while after continued manifestly trembling.

3. But having suffered him to rest a seasonable Space of Time, presuming that *Assuefaction* had accustomed him to greater Hardships, we conveyed him again into the *external Receiver*, and having brought the *Air* to the former Degree of *Expansion*, we were able to keep him there for a full quarter of an Hour. And 'tis worth noting, That till near the latter End of the quarter of an Hour, not only the *Animal* did scarce at all appear distressed, remaining still very quiet; but which is more, whereas when he was put in, the Tremblings formerly mention'd were yet upon him, and continued so for some Time, yet afterwards, in spite of the *Expansion* of the *Air* he was then in, they left him early enough. And when the *internal Receiver* was taken out, he did not only recover from his fainting Fit sooner than before, but escaped those subsequent Tremblings.

4. After we had allow'd him some Time to recollect his Strength, we re-conveyed him into the *Receiver*, and pump'd out the *Air*, till the *Mercury* in the *Gage* was not only drawn down as low as formerly, but near half an Inch lower. And tho' this did at first seem to discompose our little Beast, yet after a while he grew very quiet and continued so for a full quarter of an Hour, when we caused 3 *Exsuctions* more to be made by the Pump, before we discovered him to be in manifest Danger (at which Time the *Bladder* appeared much fuller than before:) But when we were oblig'd to let the *Air* into the outward *Receiver*, whereupon the *Mouse* was more speedily revived than one would have suspected.

And these *Trials* of the Power of *Assuefaction* seem'd the more considerable, because the *Air* in which the *Mouse* had all this while lived, had been clogged and infected with the *excrementitious Effluvioms* of his Body, for 'twas the same all along, we having purposely forbore to take off the *Bladder*.

Unfit for Respiration, yet retaining its Density

XV. 1. We took a *Mouse* of an ordinary Size, and having, not without some Difficulty, conveyed him into an oval *Glass* fitted with a somewhat long and considerably broad Neck, we conveyed in after him a *Mercurial Gage*, in which we had diligently observ'd and marked the Station of the *Mercury*, and which was so fastned to a *Wire* reaching to the bottom of the *Oval Glass*, that the *Gage* remaining in the Neck, was not in Danger to be broken by the Motions of the *Mouse* in the oval Part: The upper Part of the long Neck of the *Glass* was, notwithstanding the wideness of it, *hermetically seal'd*: And tho' by Reason of the Largeness of the Vessel in Comparison of so small an Animal,

Animal, he seem'd to me rather drooping than very near Death at the End of the *second Hour*; yet coming to look upon him about *half an Hour* after, he was judg'd by the Spectators quite dead, notwithstanding our shaking of the Vessel to rouse him up. This made me cast my Eyes upon the *Gage*, wherein I could not perceive any sensible Change of the *Mercury's Station*. But having caused the seal'd Part of the Glass to be broken off, and fresh *Air* to be blown in by a pair of Bellows, the gasping Animal revived, tho' but slowly.

2. Such an Experiment as the former we made with like Success upon a small Bird, included with a *Gage* in a *Receiver*, holding about a Quart of Water. The *Bird* in about half an Hour appeared to be sick and drooping, and the Faintness and Difficulty of *Breathing* increased for about 2 Hours and an half after that, at which Time the Animal died, the *Gage* being not sensibly altered.

3. In a *Glass Vial*, capacious enough to hold about 3 Quarts of *Water*, we hermetically seal'd up a small Bird, and found, that in a few *Minutes* he began to be sick and pant; which *Symptoms* I suffered to continue and increase against the Mind of a learned *By-stander*, who thought the Animal would not hold out so long, till they had lasted just half an Hour; at which Time having provided a Vessel of *Water*, made exceeding cold with *Sal-Armoniack*, newly put into it, the *Vial* with the sick *Bird* was immers'd in it, and kept there in that Condition for 6 Minutes; and yet it did not appear, that this great *Refrigeration* did sensibly refresh the drooping Animal. So that this Remedy proving ineffectual, the *Vial* was removed out of the *Water*, and the *Bird* sometime after did, as I foretold, make many Strains to vomit, (tho' she brought up little) followed by *Evacuations* downward, before she quite expired, which she did within a Minute or two of a just Hour after the Beginning of her Imprisonment.

XIV. We made by *Distillation* a Blood red Liquor, which I have with very little variation communicated in the *History of Colours*, and which chiefly consists of such *saline* and *spirituous* Particles as may be obtained from the *Mass* of *Blood* in human Bodies; this *Liquor* is of such a Nature, that if a *Glass-Vial*, about half fill'd with it, be kept well stopp'd, the red Liquor will rest as quietly as any ordinary one, without sending up any Smoke or visible Exhalation; but if the *Vial* be unstopp'd, so that the *external Air* be permitted to come in and touch the Surface of the Liquor, within a quarter of a Minute or less, there will upon this Contact be elevated a copious white Smoke, which will not only fill the upper Part of the Glass, but plentifully pass out into the open Air, till the *Vial* be again stopp'd. This *Experiment* may serve to illustrate the Office of the *Air* to carry off in *Expiration* the *suliginous Steams* of the *Lungs*. For, in our Experiment we manifestly see, that the very Contact of the *Air* may give the *Corpuscles* of moist Bodies a peculiar Volatility, or Facility to emerge in the Form of *Steams*. It may here suffice to take notice of these two Things: The one is, that when the *Vial* has lain stopp'd and quiet a competent Time, the upper Half of it will appear destitute of *Fumes*, of which the *Air*, it seems, will imbibe, and constantly retain but a certain moderate Quantity, which may give some Light towards the Reason, why

The use of
Air in Re-
piration.

Why the same *Air*, which will be quite clogged with *Steams*, will not long serve for *Respiration*, which requires frequent Supplies of fresh *Air* : The other is, That if the *unstopped Vial* were placed in our *Vacuum*, it would not emit any visible *Steams* at all, nor so much as to appear in the upper Part of the *Glass* it self that held the *Liquor*; whereas, when the *Air* was by degrees restored at the *Stopcock* without moving the *Receiver* it self, to avoid injuring its Closeness, the returning *Air* would presently raise the *Fumes*, first into the vacant Part of the *Vial*, whence they would ascend into the Capacity of the *Receiver*; and likewise, when the *Air* that was requisite to support them was pumped out, they also accompanied it, as their unpleasant Smell evinced, and the red Spirit, tho' it remain'd unstopped, emitted no more *Fumes* till the *Air* was let in.

Snails, Efts,
and Leeches.

XVII. 1. Two *white Snails* without *Shells* of differing Sizes, (the biggest about an Inch and a half, and the other about an Inch in Length) were included in a small portable *Receiver*, which was carefully *exhausted*, and secured against the Return of the *Air*. Presently after 'twas remov'd from the *Engine*, it was easy to discern that both the *Snails* thrust out and retracted their *Horns* (as they are commonly call'd) at pleasure, tho' their Bodies had in the softer Places pretty store of newly generated *Bubbles* sticking to them: But tho' they did not lose their Motion near so soon, as other *Animals* were in our *Vacuum* wont to do, yet coming to look on them after some Hours, they appear'd moveless and very tumid, and at the End of 12 *Hours*, the inward Parts of their Bodies seem'd to be almost vanished, and they seem'd to be but a couple of small full blown *Bladders*; and on the letting in of the *Air*, they immediately so shrunk, as if the *Bladders* having been pricked, the residing *Air* had left behind it nothing but *Skins*; nor did either of the *Snails* afterwards, tho' kept many Hours, give any Signs of Life.

2. We included in a *Receiver*, whose globular Part was about the bigness of a large *Orange*, one of that Sort of *Animals* that they vulgarly call *Efts*: Having withdrawn, but not solicitously, the *Air*, we kept him there about 48 Hours: During all which Time he continued alive, but appeared somewhat swelled in his Belly; his under-chap moving the very first Night, but not the Day and Night following. By opening the *Receiver* at length under Water, we perceived, that about half the *Air* had been drawn out. As soon as the Water was impelled into the *Glass*, the *Animal* that was before dull and torpid, seem'd, by very nimble and extravagant Motions, to be strangely revived.

3. We took a *Leech*, that was of a moderate Bigness, or somewhat short of it, and having included it together with some *Water* in a portable *Receiver*, that was guels'd to be capable of holding about 10 or 12 *Ounces* of that *Liquor*, the *Air* was pump'd out after the usual Manner, and the *Receiver* being remov'd to a lightsome Place, we observed, as we expected, that the *Leech* keeping her self under Water, there emerged from diverse Parts of her Body store of *Bubbles*, some of them in a disperfed Way, but others in *Rows* or *Files*, if I may so speak, that seem'd to come from determinate Points. Though this Production of *Bubbles* lasted a pretty while, yet the *Leech* did not seem to be

very much *discomposed* by her present Condition: For after 5 Days (tho' the *Receiver* continued well exhausted) we found her very lively.

XVIII. 1. We took 5 or 6 *Caterpillars* of the same Sort; and had the *Air* ^{Creeping In-} drawn from them, and carefully kept from returning. About an Hour after, I found them moving to and fro in the *Receiver*, and even above two Hours after that, I could by shaking the Vessel, excite in them some Motions, that I did not suspect to be convulsive. But about 10 Hours after they were first included, they seem'd to be quite dead; yet the *Air* being forthwith restored to them, I found the next *Day*, that 3 or 4 of them were perfectly alive.

2. We took from a Hedge a Branch that had a large *Cobweb* of *Caterpillars* in it, and having divided it into two Parts, we put them into like *Receivers*; and in one of them shut up the *Caterpillars* together with the *Air*, which from the other was exhausted. The Event was, that in that which had the *Air*, the little and difficultly visible *Insects*, after a small Time appeared to move up and down as before, and so continued to do for a Day or two; whereas that *Glass* whence the *Air* had been drawn out, and continued kept out, shewed, after a very little while, no Motion that we could perceive.

XIX. 1. Nov. 12. 8 at Night. There were taken 4 middle siz'd *Flesh-flies*, ^{Winged In-} which having their Heads cut off, were inclosed in a portable *Receiver*, furnished with a pretty large Pipe and a Bubble at the End. As soon as the *Receiver* was exhausted, those *Flies* lost their Motion (which was not brisk before;) an Hour or two after. I approached them to the Fire, which restored not their Motion to them (but as to one of them I suspected it had a languid Motion for a while;) wherefore I let in the *Air* upon them, after which in a very short Time, tho' not immediately, they began one after another to move their Legs, and one or two of them to walk.

2. Sept. 11. About Noon. We closed up diverse ordinary *Flies*, and a *Bee* or *Wasp*; all which, when the *Air* was fully withdrawn, lay as dead, save that for a very few Minutes some of them had convulsive Motions in their Legs; they continued in this State 48 Hours, after which, the *Air* was let in upon them, but none of them recovered.

3. Decem. 11. at Night, we put a great *Flesh-Fly* into a very small portable *Receiver*, where at first it appear'd to be very brisk and lively, but as soon as the *Air* was drawn out, fell on his Back, and seem'd to have convulsive Motions in her Feet and *Proboscis*, from whence she presently recover'd, upon the letting in of the *Air*; which being drawn out again, she lay as dead, but a while after, (within a quarter or half an Hour) I perceived, that upon shaking the *Receiver*, she stirred up and down, but faintly. The next Night, by Warmth, and letting in the *Air*, the *Fly* recovered: But being next Morning seal'd up again in that *Glass*, and kept 48 Hours, tho' over the Chimney, she died for good and all.

4. We took a large *Grass-hopper*, whose Body, besides the Horns and Limbs, was about an Inch in Length, and of a great Thickness in Proportion to that Length: This we convey'd into a portable *Receiver* of an oval Form,

and capable of holding, by our Guess, about a Pint of *Water*. When the *Air* began to be considerably rarefied, he appeared to be very ill at Ease, and seemed to sweat out of the *Abdomen* many little Drops of Liquor, which being united, trickled down the Glass like a little Stream, which made at the Bottom a small Pool of clear Liquor, amounting to near a *Quarter* of a *Spoonful*, and by that time the *Receiver* was ready to be taken off, the *Grass-hopper* was fallen upon his Back, and lay as dead, and continued so for 3 *Hours*; after which, the *Air* being let in upon him, he continued without any Signs of Life for a *Quarter* or Half an *Hour*: But being carried into a sun-shiny Place, the Beams of a declining Sun presently began to make him stir his *Limbs*, and in a short time brought him perfectly to Life again.

5. *Apr. 15.* We took one of those shining *Beetles* they call *Rose-Flies*, and having included it in a very small round *Receiver*, which we exhausted; and tho' it struggled much whilst the *Air* was withdrawing, yet presently after, I could perceive but little Motion (and part of that seem'd almost convulsive.) About six *Hours* after, it seem'd quite dead, and upon the Return of the *Air*, no Sign of Life ensued for a pretty while, but three or four *Hours* after, I found him lively enough.

6. Having observed *Butterflies* not only to live, but to move longer than was expected, I included diverse of them in somewhat large *Receivers*, and tho' whilst the *Air* continued in the *Glasses*, they flew actively as well as freely up and down; and tho' after the *Exhaustion* of the *Air* they continued to live, and were not moveless; nay, tho' at the Bottom of the *Receiver*, they would even move their *Wings*, and a little flutter: Yet I could not perceive any of them to fly, by which, I mean, perform any progressive Motion supported by the Medium only. And by frequently inverting the *Receiver* (which I took Care should be pretty long, to let them fall from one Extream to the other) they would fall like dead Animals, without displaying their *Wings*, tho' just as they came to touch the Bottom, some of them would sometimes seem to make some Use of them, but not enough to sustain themselves, or to keep their Falls from being rude enough.

Ants and
Mites.

XX. 1. A pretty Number of *Ants* were included in a small portable *Receiver*, exhausted yesterday about Noon. They grew almost moveless as soon as the *Air* was exhausted: And between 6 and 7 in the Afternoon, they seem'd to be all quite dead. Whereupon I opened the Glass, and tho' no Sign of Life appear'd for a great while, yet this Morning I found many of them alive, and moving to and fro.

2. We convey'd a pretty Number of *Mites*, which are reputed but living Points, together with the mouldy Cheese they were bred in, to nourish them, into 3 or 4 very small *Receivers*. One of them with the *Air* in it was seal'd up at a Lamp Furnace, and from all the rest we withdrew the *Air*. This done, we observ'd the following *Phænomena*, viz.

1. Those *Mites* that were inclosed in the small Glass that never came near the Engine, continued alive, and able to walk up and down for above a full Week, after they had been put in; and possibly would have continued much longer, if the Glass had not been broken.

*

2. Though

2. Though just before the *withdrawing* of the *Air*, the *Mites* were seen to move up and down in it; yet within a few *Minutes* after the *Receiver* was applied to the *Engine*, I could discern in them no *Life* at all, tho' my *Eye* was assisted with a double convex *Glass*. Above an *Hour* after, I could not perceive any of them to stir: 2 or 3 *Hours* after that, I let in the *Air*, and left the *Receiver* unstop'd in a *Window*.

3. About 2 or 3 *Days* after, I found a *Number* of my little *Animals* received, as an attentive *Eye* might easily perceive by the *Motion* of certain little white *Specks*, and they continued to appear alive for 2 or 3 *Days* after that, if not longer.

4. One of the *Receivers* was kept exhausted from *Monday* to *Tuesday*; after all which time, our attentive *Eyes* being unable to discover any *Signs* of *Life* among the included *Mites*, the *Air* was let in upon them, and after a long time, could plainly see them creep up and down in the *Glasses* again.

LXXVIII. We took *Filings* of crude *Copper*, and put them into a crystal-
line *Glass* of a conical *Shape*, into which we poured some strong *Spirit* of
Salt, (that was fitted for our peculiar Purpose) to the *Height* of about a *Finger's*
breadth above the *Filings*, and then closing the *Vessel* with a *Glass-stopple*,
exquisitely fitted to it, we suffered it to continue unmoved in a *Window* for
some *Days*, till the *Liquor* had both obtained a high and darkish brown
Colour, by the *Solution* of some of the *Copper*, and lost that Colour again,
growing clear like common *Water* (which is it self a somewhat odd *Phenomenon*),
and then taking out the *Stopples*, without shaking the *Liquor*, and
thereby giving Access to the outward *Air*, we perceived, as we had conjectured,
that the upper *Surface* of the *Liquor* did in a few *Minutes* re-acquire a
darkish brown Colour; which penetrating deeper and deeper, at the *End* of
about a *Quarter* of an *Hour*, the whole *Body* of the *Liquor* appeared to be
likewise tinged. The conical *Glass* being again well stop'd, the *Menstruum* did
again in very few *Days* let fall, or otherwise lose its *Tincture*, which the
Stopples being taken out, it regained as before. Nor were these 2 the only
Trials I made with the like Success for the main; but afterwards being desirous
by a farther *Trial* to resolve a *Doubt* I had, I kept the *Glass* yet longer
in the same *Place* with the same *Filings* and *Menstruum* in it, for, if I mis-
remember not, a *Month* or two together; but observed not that the *Liquor*
would any more grow clear.

2. Having taken another conical *Glass*, wherein the *Liquor* was grown
clearer than is usual, and had probably been so a good while before, for the
Vessel having been hid by others which stood before it, had been for some
Weeks forgotten; we took out the *Stopples*, and left it out for about half an
Hour, but did not perceive the *Liquor* to have acquired any Colour, so much
as at the *Top*. But putting in the little *Stopples*, I left the *Vessel* closed for
2 or 3 *Hours*, and at my *Return* to visit it, I perceived, that it had acquir-
ed a faint Colour tending to a *Green*; Wherefore, taking out the *Stopples*
again, I opened its *Commerce* with the outward *Air*, leaving the *Glass* unstop'd
for 20 or 24 *Hours*, but found that in all that time it had not regained its

wanted dark Colour, but was only arrived at a Green, deep enough, but not true nor very transparent.

This Observation being made in the same Vessel that had been formerly employed, suggested to us an Enquiry, whether the advanced Time of the Year, which was the middle of *October*, might not have an Interest in the *slow* and *imperfect* Success of this Trial?

3. Some strong *Spirit* of *Salt* having been kept upon *Filings* of *Copper* till the Solution was come to be of a dark *brown* Colour, about three Spoonfuls of it, by guess, was put into a *Receiver* that might hold 8 or 10 Times as much: Being kept in *Vacuo*, if the Time be rightly remember'd, about half a Year, it retain'd its Colour, but the Vessel being open'd, and the external Air permitted a free Access to it, the Solution in about an Hour was turned into a fine transparent Green, tho' no Precipitation of any muddy Substance appeared by any Sediment to be made.

4. In one of that Sort of *Conical Glasses* that has been already describ'd, we had put upon some *Filings* of *Copper* a convenient Quantity of our *Spirit* of *Salt*; and tho' we observ'd, that for a great while it would not part with its deep and somewhat muddy *Tincture*; yet we left it in the *Window* for many *Weeks* longer, and at length, towards the latter End of *December*, we found it to have lost its *Tincture* so much, that the Liquor appeared like common *Water*. Upon which Observation, tho' the Time of the Year were unpromising, I thought fit to try whether the Air in that Season would not have some, tho' perhaps but a slow Operation on the *saline Spirit*; and accordingly taking out the Glass Stopple to give free Access to the *outward Air*, we observ'd, that in some Hours its Operation on the Liquor was scarce sensible; but within about 24 Hours, the *Menstruum* had acquired not just its former Colour, but a somewhat faint and moderately transparent Green: So that this tinted *Menstruum*, as it had been very slow in losing its Colour, so it did but slowly and imperfectly re-acquire it.

5. We took some *Filings* of *Copper*, and putting them, together with a *Mercurial Gage*, in a *Conical Glass* fitted with an exactly ground Stopple of the same Matter (which was *Crystalline*) we poured on the *Filings* as much rectified *Spirit* of *fermented Urine* made *per se*, as sufficed to swim an Inch or better above them; then carefully stopping the Glass, coming to look on it many Hours after, we perceived that the *Mercury* in the seal'd Leg was considerably deprest, and gently drawing out the Stopple, to let in the *outward Air*, we perceived that Access to have a manifest Effect upon the *Mercury*.

6. We took a *Crystal Glass* of an almost *Conical Shape*, and capable of containing between 5 or 6 Ounces of *Water*, and furnish'd with a Stopple of the same Matter, that by grinding was exactly fitted to it. Into this we put a considerable Quantity of clean *Filings* of good *Copper*, on which we poured as much strong *Spirit* of *Fermented*, or rather *putrify'd Urine*, as served to swim about an Inch above the *Copper*, and having let down a *Mercurial Gage*, so that it lean'd upon the Bottom and Side of the *Glass*, we clos'd it very well with a Stopple, and set in a quiet and well enlightned Place, having taken good

notice

notice at what Mark the *Quick-silver* rested in the *open Leg* of the *Gage*. This done, we let in the *Menstruum* alone to work upon the *Filings*; which it did, as we foresaw, somewhat slowly and very calmly, without producing any *Noise* or sensible *Bubbles*, acquiring by Degrees a very pleasant *blue* Colour; and the *Glass* being kept quiet in the same Place for 2 or 3 *Days* longer, the *Liquor*, as I conjectured would happen, began to lose of the *Intenseness* of its Colour, which by Degrees grew fainter and fainter, till at the End of 3 or 4 *Days*, the *Liquor* was grown very *pale*, and let me little doubt but that, if I would have stayed some *Days* longer, it would have lost the remaining Eye of *Blue*, and have look'd almost like common *Water*. But being unwilling to tarry so long, I took out the *Stopple*, that the *Air* without the *Glass* might have Access to that within; and leaving the *Vial* in the same Place and Posture, my Expectation was somewhat answered by finding, that within 4 or 5 *Minutes*, if not less, the upper Part of the *Liquor* that was *contiguous* to the *Air*, had acquired a fine *blue* Colour, which descending deeper and deeper, before the End of the 10th *Minute* had diffused it self, but somewhat weakned, through the *Liquor*, whose Colour was suffered to deepen for a while longer; so that in less than a *quarter* of an *Hour* from the first unstopping of the *Vial* the *Liquor* was grown to be throughout of a rich *ceruleous* Colour, which grew almost too opacous within a few *Minutes* longer: When carefully closing the *Vial* again with the same *Stopple* as before, we set it aside in the same Place, where the *included Air* being denied all Commerce with the *external*, the *Liquor* began again within 2 or 3 *Days* to lose of its Colour; and, to be short, afforded me the Opportunity of making a 2^d Experiment much like the former. And the like Success I had, for the main, in a Trial or two made in another *Glass* with another Portion of the same *Spirit* of *Urine*, put upon the *Filings* of *Copper*; so that the Experiment was, in all, made diverse Times, as well when I was not, as when I was alone: And particularly, once to be sure that the diurnal *Air*, as such, had not any great Interest in the *Phenomenon*: I made the Trial successively about Nine a-Clock at Night.

In most of these Experiments I forbore to shake the *Glass*, lest it should be suspected, that the Agitation of the *Liquor* might have raised some little fine Powder that might have been supposed to have been *precipitated* out of the *Tincture*, and, being thus mingled with the *Liquor* again, restore it to its former Colour; but in Truth I did not perceive any such Powder to be *precipitated*. And though to obviate the Objection, I forbore to shake the *Vial*, yet I justly supposed, that if, by the Agitation of the *Liquor*, more Parts of it should be quickly exposed to the Action of the *Air*, the Coloration would be hastned, which upon Trial appear'd to be true.

7. We took such a canonical *Glass*, as has been lately describ'd, and covering the Bottom of it with a convenient Quantity of *Filings* of good *Copper*, we poured on them as much strong *Spirit* of *Sal Armoniack* as served to swim about a Finger's breadth above them; and, having let down such a *Mercurial Gage* as is formerly mentioned, so that it leaned upon the Bottom and Side of the *Glass*, we closed it very well with a *Stopple*, and set it in a quiet and

and well enlightn'd Place, having taken good notice at what Mark the *Quick-silver* rested in the open Leg of the Gage: This done, we let alone the *Mensstruum* to work upon the *Filings*, which it did, as we foresaw, somewhat slowly and very calmly, without producing any *Noise* or sensible *Bubbles*, acquiring by Degrees a very pleasant *blue* Colour, and afforded us also the *Phænomemon* we chiefly look after; which was, that repairing from time to time to the Window to see what pass, we perceived, that for 2 or 3 days together the *Mercury* in the seal'd Leg of the Gage did, though very slowly, descend till it appeared to be near a Quarter of an *Inch* lower than at first; and probably the Depression might have been greater, if the Experiment had not been disturb'd; whose Event yet seem'd sufficiently to argue, that the *Spring* of the *Air* contain'd in the Cavity of the Glass, and communicating with that in the open Leg of the Gage or Syphon, was weakened in Comparifon of that in the closed Leg, which by the *Hermesick Seal* on one side, and the *Quick-silver* on the other, was kept from such Communication. And I was farther careful to observe, whether the Depression did not continue at differing times of the *Day*, and found it to do so, as well at *Night* as at *Noon*, though at this last named time the *Sun* shined hot upon the Place and *Vessels* too.

This Experiment was made, in all, 4 or 5 times, though not always with equal, yet still with some Success, the *Mercury* in the seal'd Leg of the Gage being sometimes more, and sometimes less, but always manifestly depressed; which *Phænomemon* was confirmed, by the Observation we more than once made of the sudden Return of the *Quick-silver* to its former Station, upon the unstopping of the Glass, to give free Admission to the outward *Air*.

8. A *Mercurial Gage* having been put into a Conical Glass, whose Bottom was covered with beaten *Coral*, some *Spirit of Vinegar* was poured in, and then the Glass Stopple, which was very well ground, closing the Neck exactly, we observed, that upon the working of the *Mensstruum* on the *Coral*, Store of *Bubbles* were for a good while produced, which successively broke in the Cavity of the Vessel; and their Accession so constipated the *Air*, that they compressed the *Air* imprisoned in the closed Leg of the Gage three Marks for Divisions which I guessed to amount to about the third part of the Extent it had before: But some Hours after the Corrosion had ceased, the Compression made by this new generated *Air* grew manifestly fainter, and the imprisoned Gage *Air* drove down the *Mercury* again till 'twas depressed within one Division of its first Station; and thereabouts, or a little lower, continued 5 or 6 Days; so that in this Operation there seemed to have been a double Compressive Power exercised; the one transient, by the brisk Agitation of *Vapours* or *Exhalations*, and the other durable, from the *Aerial* and Springy Particles either produced or extricated by the Action of the *Spirit of Vinegar* upon the *Coral*.

But a pretty Quantity of *Spirit of Vinegar* being put upon *Minium*, it continued diverse Days without any sensible Depression of the *Mercury* in either Leg, nor did any Change appear in the Gage, upon the Removal of the Stopple, though 'twas evident by the great Sweetness acquired, that it had made a Solution of a great Portion of the *Minium*.

9. We took some *Filings* of *Copper*, and in a *Vial* capable of holding some 2 or 3 *Ounces* of *Water*, we poured on them strong *Spirit* of *Sal Armoniack* made without *Quicklime*, till the *Liquor* reached near an *Inch* above them. This was done about the 20th of *August* on the *Friday* before *Noon*, and the following *Monday*, presently after *Dinner*, it had acquired a deep *Blue Tincture*, and lost again so much of it, that it was pale almost like common *Water*: Then to satisfy a *Virtuoso*, I unstopt the *Vial*, desiring him to place his *Eye* level with the *Surface* of the *Liquor*, which in a *Minute* of an *Hour* or less appeared to his *Surprise* and *Wonder* to have acquired a deep *Blue Tincture*, that reached downwards to the *Thickness* of the *Back* of a *Knife*, the whole *Liquor* becoming of the like *Colour* in 4 or 5 *Minutes* more, and the *Glass* being presently stopt again, and left where 'twas before, appeared not at the *End* of 9 *Days* to have lost its *Tincture*; tho' now and then within that *Time* it seemed manifestly paler than when the *Vial* was stopt.

10. We took a round *Vial*, holding about 8 *Ounces* of *Water*, and having put into it *Filings* of *Copper* and a *Mercurial Gage*, we poured on the *Metal* strong *Spirit* of *Sal Armoniack*, till it reached to a good *Height* in the *Vial*, which then being *Hermetically sealed* up, was set by in a *South Window*, where it quickly acquired a deep *Blue Tincture*: There it stood about 12 *Days*, before that *Tincture*, which decayed but slowly, did little by little grow so diluted that the *Liquor* was pale and almost like *Water*; during this stay of the *Glass* in the *Window*, the *Mercury* in the open *Leg* appeared to be impell'd up; and when after 9 a *Clock* at *Night* (which *Time* I chose to try whether the nocturnal *Air* would have any thing to do with the *Phenomenon*) the *hermetick Seal* was broken off; immediately upon which there was produced a *Noise*, and the *Mercury* in the shorter and closed *Leg* was briskly impelled up, by our guess, near $\frac{1}{4}$ of an *Inch*; and tho' the *Orifice* at which the *Air* had *Access* was scarce wide enough to admit a middle siz'd *Pea*, yet within a *Minute* and half the *Surface* of the *Liquor* being held between the *Eye* and the *Candle*, appeared to have acquired a very lovely and fair *Colour*, which reached downwards a quarter of an *Inch*; so that the *Vial* seemed to contain two very differing *Liquors* swimming one on another; and the *Coloration* piercing deeper and deeper within 5 *Minutes* in all, the whole *Liquor* had attained a rich *Blue Colour*.

LXXIX. 1. To mingle diverse *Liquors* together by means of the *Air Pump*, there were employed two small *Glasses*, whereof the one could enter into the other, and the least of the two was fasten'd to the *Hook* of an *Iron Wire*, and the greater put under it, and the said *Wire* was so ordered, that these two *Glasses* were a little distant one from another. The *Recipient* was of a *Cylindrical Figure*, of which one *End* is all open, to be fastned to the *Cement* of the *Pump*; the other is all closed, except a small *Hole*, having a little *Edge* or *Brim*; thro' which *Hole* you pass the hook'd *Iron Wire*, and tye an *Eel-Skin* close about the same; and three or four *Inches* higher, the same *Skin* is also to be tyed about the *Iron Wire*, to keep the external *Air* from entering into the *Recipient*, and yet without taking away the *Liberty* to stir therein what you will by means of the *Iron Wire*, that bath

Pneumatical
Experiments,
by M. Papin:
Directed by
M. Hugenot,
n. 119. p.
443.

hath a Communication *inwards* and *outwards*. For this Purpose you must chuse that Part of the *Eel-Skin* that is next to the Head, the other Part being pierced with many *Holes* with *Valves* that do not always shut well.

To be the more sure that no Air enters by the Ligatures of the *Eel-Skin*, you may apply a Tube on the *Recipient* with Cement, and pour Water into this Tube until the *Eel-Skin* be quite cover'd therewith. Care also must be had, that the Hole be exactly filled up by the *Iron Wire*; for, if it were too big, the *Eel-Skin* would be thrust into it with great Violence, and so hinder the Liberty of raising and sinking it.

When the *Recipient* was evacuated of Air, the lesser Glass was by the *Iron Wire* let down into the greater, until the Liquors they contain did mingle themselves. Thus some *Aqua-fortis* was poured into the upper Glass, and *Spirit of Wine* into the lower, and the *Recipient* was so well exhausted of Air, that the *Spirit of Wine* boyled up with great Bubbles (as usually it doth) and the *Aqua-fortis* cast some small Bubbles. After that both these Liquors were well purged of Air, the upper Glass was sunk into the lower, so as that the *Spirit of Wine* was mingled with the *Aqua-fortis*, at which Instant there was yet seen a very considerable *Ebullition*.

Now to know whether the *Aqua-fortis* gave to the *Spirit of Wine* some new Vigor or Force to make it bubble, we mixed without the *Recipient* some *Aqua-fortis* with *Spirit of Wine*; the Quantity of the former being somewhat more than that of the latter. This Mixture being put in *Vacuo*, instead of boiling up more strongly than the *Spirit of Wine*, (as 'twas thought it would have done) it only cast up some few Bubbles: Which shewed that the *Ebullition*, which was seen when they were mixed within the *Vacuum*, is of the same Nature with all those that are made of *Acids* and *Acalies*. For, in the very instant that they are mixed they make great *Ebullitions*, but soon after they mortifie one another, and lose the Properties they had before.

'Tis also probable, that the *Aqua-fortis* and the *Spirit of Wine* would boyl always when they are mingled, but that the Pressure of the Air keeps this *Ebullition* from being sensible, and appears only when that Pressure is taken off.

When you employ rectified *Spirit of Wine* instead of *Aqua-vitæ*, there is required a greater Quantity of *Aqua-fortis* to mortifie it.

It was also experimented, that the *Solution* of common Salt boyls also with *Spirit of Wine*, being mixed in *Vacuo*; and the *Solution* of Salt Peter yet more. The same Experiment was also made with common Water, and its *Ebullition* with *Aqua-vitæ*, purged of Air, was also found to be very great, when mixed in *Vacuo*.

Farther, it is somewhat remarkable, that common Water doth not mortifie *Spirit of Water*, as *Aqua-fortis* doth, though they make *Ebullitions* with it almost of the same Degree. The Experiment of it is easy: For, making without the *Recipient*, a Mixture of common Water and *Aqua-vitæ*, this being put within the *Vacuum*, bubbles up very well, though the common Water be there

there in greater Quantity than the *Aqua-vitæ*; whereas a Mixture of *Aqua-fortis* and *Aqua-vitæ* did not there bubble up at all.

After this, the Experimenter being desirous to see whether these *Ebullitions* did make *new Air*; he put in the *Recipient* a Gage (that is a Glass Tube fill'd either with Water freed of Air, or with *Mercury* serving to measure the Quantity of the Air in the *Recipient*) which was 4 Inches long, and observed, that at the Instant when the Liquors were mingled together, the *Water* in the Gage rose very nimbly to the Top of the Gage; and then drawing out this *new Air* that was made, he made the *Gage-Water* subside again by Degrees, in like manner as when the *common Air* is drawn out: And by this means it was seen, and all these kinds of *Ebullition* made an Air which expands it self like *common Air*. Yet it is very remarkable, that the Air which is made by these *Ebullitions*, is not of the same Nature; For it hath been found experimentally, that the Air formed by the Mixture of *Aqua-fortis* and *Copper* remains always Air, and always keeps up the *Water* in the *Glass* at that Height to which it raised it; but on the contrary, that *Air* which hath been produced by the Mixture of *Oyl of Tartar*, and *Oyl of Vitriol*, is almost all destroyed of it self in the space of 24 Hours, in-somuch that in the *Recipient*, 24 Hours after the *Ebullition* had been there made, there was not found much more *Air* than there was before the same was made.

2. Mr. Boyle (as 'tis recorded in the *Journal Book* of the *Royal Society*, Apr. 30. 1668.) gave an Account to the said *Society* of the Experiments he had then made about generating *new Air*, or extricating that *Air* which was lurking before in several Bodies: At which Time he mentioned also some ways of examining, whether the Substance thus produced be *true Air* or not.

And long before that Time, viz. An. 1664. the 15th of Mar. (Witness the same *Journal*) Mr. Boyle mentioned to the *R. Society*, that *Corals* or *Oyster-Shells* pounded, and put into *distill'd Vinegar*, might prove fit Substances to produce *Air*, wholesome for *Inspiration*. At which Time he also proposed that some fit Animal might be put into a *Receiver* of his exhausting Engine, and the *Air* pump'd out till the Creature grew sickish, and that then some *new Air* might be produced in the *Receiver* by a Contrivance of making *distill'd Vinegar* work upon the Substances before mentioned, to see whether by this means the Animal would recover.

About which time Sir Chr. Wren also suggested, to put a fermenting Liquor in a Glass Ball, and to fit a *Stop-Cock* to it, and tye a Bladder about the top of the *Stop-Cock*, by which means the *Air*, to be generated by the *Fermenting* Liquor, would pass into the Bladder, and upon the turning of the *Stop-Cock* be kept there in the form of *Air*. Mr. Hook also mentioned several Liquors, which by their working upon one another would produce an *Air*; as *Oyl of Tartar* and *Vitriol*; *Spirit of Wine* and *Turpentine*. And the same made before the *R. Society* the following Experiment: He took a common Glass Vial with two Pipes, and some pounded *Oyster-Shells* and *Aqua-fortis*; and as soon as the latter was by one of those Pipes poured upon the former, and the Hole stopt with good Cement, the *Ebullition*, caused by the

Shells being corroded by the *Aqua-fortis*, did in a very little Time blow up the Bladder, tyed on the other Pipe, so as to swell it very plump with *Air*; which Expansion remained till the *Society* rose, after they had order'd the said Vessel to be carefully lock'd up till their next Meeting, which being the Week after, the Bladder was then found somewhat shrunk. The like Experiment was made with Bottled Ale, supposed to yield a more wholesome Air for Respiration.

3. One Day we mingled equal Parts of *Aqua-fortis* and *Aqua-vitæ*; and having put two equal Quantities of this Mixture in two small Glasses with two equal Bits of *Iron*, one into each; one of the Glasses was included in *Vacuo*. Then there was seen a very great *Ebullition*, and the Liquor became black, whilst that which was left without the *Recipient* wrought almost nothing, but remained always transparent, and rather White than Black. After these two Glasses had stood thus 12 Hours, that which was in *Vacuo* was taken out, and we found that the *Iron* was almost all dissolved, whereas the other was very little diminished. This Experiment succeeds quite contrary when 'tis made with *Aqua-fortis* alone and *Copper*; for then the *Dissolution* is less within the *Vacuum*, than without it.

We made some other Mixtures of diverse Liquors, which make no *Ebullition* at all in *Vacuo*, no more than they do in open Air. *Oyl* of *Olives* makes none neither with *Vinegar*, nor with *Spirit* of *Wine*, at the instant that they mingled; neither doth the said *Oyl* mortify the *Spirit* of *Wine*. Only this we observed one Day, that having mingled together, without the *Recipient*, some of that *Oyl* and *Vinegar* and *Spirit* of *Wine*, and put this Mixture in *Vacuo*, it did not boyl up so soon as when there was no *Oyl*; but then the Bubbles which it made afterwards were bigger, and they began to appear again from Time to Time, so that some of them were seen a Quarter of an Hour after the *Recipient* had been evacuated. Possibly this may come to pass, because that the *Oyl*, swimming on the Top, retains the more volatile Parts of the *Spirit* of *Wine*, which else would fly away as soon as the Air is begun to be pump'd out, and at the same Time it hinders the Surface of the Liquor below from easily rising up into Bubbles, because, to make them do so, the Parts of the *Oyl*, that stick close to one another, must be separated. When therefore the volatile Parts are gathered together in a sufficient Quantity, able to surmount the Resistance which the *Oyl* makes to it, they issue out with much more Violence, than if nothing had retained them.

All these *Ebullitions*, hitherto spoken of, are greater in *Vacuo* than in the open Air: But with *Lime* it is not so. For, taking two equal Glasses with two equal Quantities of *Water*, and putting the one of them in *Vacuo*, the other in the free Air, there was let fall into both at the same Time two equal Parcels of *Lime*, one into each; and it appear'd, that that which was in *Vacuo* did indeed throw up some big Bubbles, but yet fewer of them than that which was in the Air; and having taken it, an Hour after, out of the *Recipient*, and stirred the *Lime*, it was found to have only the Consistence of Dirt, whereas the other had the Consistence of *steeled Lime*. The Reason of which

which may perhaps be, that the *volatile Salts* of the *Lime* do exhale whilst the *Recipient* is emptying.

There was also some *Plaster of Paris* flecked in *Vacuo*, and the *Ebullition* of it did there appear much more than it doth in the open Air. When it is not touched, the Bubbles that issue out leave great Holes in it, and then it settles very uneven; but taking care to stir it until the *Bubbles* be come forth, and pressing it when it begins to settle, it becomes very smooth, and hath not so many little *Holes* as the *common Plaster*.

I took one Day a small *Recipient*, and instead of the *Iron Wire*, I passed in- to the little *Hole* a Sprig of a known Plant, which was *Balm*, so as that the *Top* of the Plant was within the *Recipient*, and the *Roots* without. Then I closed the rest of the *Hole* with *Cement*, and when I had taken away my little emptied *Receiver*, with the Plant half shut up therein; I put the whole into a great Glass fill'd with *Water*, the Root being downwards; and I saw that there were formed little *Water Drops* upon the Leaves that were in *Vacuo*. I left it 10 Days in this Condition, and during that Time there were entered about two Spoonfuls of *Water* into the *Receiver*, and in all Appearance this *Water* had pressed through the Plant. Yet there appeared no more any Drops upon the Leaves; but that might very well come from the grosser *excrementitious Matter* that is in the *Water*, which had stopp'd the *Conduits*.

After this, to know whether any Air had been form'd there, I replaced the *Receiver* upon the Engine, and having whelmed a bigger upon it, I saw there was but very little Air formed in the small one, because the great *Recipient* was almost all empty before the Air included in the little one could lift it up. Yet at last it did raise it, and I inclined the Engine, to the End that the little *Receiver* might not be applied to its *Cover*, when I should let the Air re- enter; and after this Manner both the *Recipients* were filled in the same Time. Then I looked upon the Leaves of the Plant; they were not withered, though they were not grown; only the Leaves had in the Middle a little changed their Colour, and had a Smell somewhat fowrish; but the next Morning the Plant was quite spoiled. We may believe that the Pressure of the Air had made the *Water* enter into this Plant with so great a Violence, that thereby it had, as it were, mortified the Parts, especially in the Middle where the Leaves were most tender; but this *Water* still kept the Leaves extended, and so they withered not; but, when the Air came to act upon them, the Parts of the Plant which had so much suffered were soon corrupted by it. For 'tis very probable, as well by this Experiment, as by others hereafter to be mentioned, that the Air is a dissolvent which corrupteth Bodies.

This being done, I made the Experiment the other Way, that is, with the Leaves in the Air, and the *Roots* in a *Bottle* of *Water* that was in *Vacuo*; and immediately I saw Air-Bubbles issuing out at the End of the Tail in *Vacuo*. After this, I put *Water* upon the Leaves, to see whether this Air came from thence, and I saw indeed soon after, that these Bubbles began to cease; and having taken away the *Water* wherein the Leaves were, I saw that

that the Bubbles began to issue out at the Tail as before: And I saw them still come out 24 Hours after, but in little Quantity; and at length it quite ceased. During these 24 Hours the Roots did lengthen about four Lines, that is, one Third of an Inch, which is little less than they ordinarily do in the Air.

I kept the Plant in this Condition for four Days upon the Engine, and took care from Time to Time to draw out the Air that entered into it by the Leaves; and then it began to wither, and the Roots shot no more.

Another Time I put two Twigs of Balm, each into a Vial full of Water, and at the End of 5 Days, when I saw manifestly that they both shot Roots, I included in the Vacuum that of the Two which had the longest Roots, without taking it out of its Vial. At the end of three Days, observing that it was wither'd in Vacuo, I took it out, and changed the Vials of the Twigs, to see, whether that which remained in the Air, and did thrive very well in common Water, would also thrive in Water freed of Air; and whether that which was withered in Vacuo would revive in the common Water and in Air. Four Days after I found the Twig that had been in Vacuo quite spoiled, and the other still verdant, but not thriving; and I observed, that it did not begin to shoot in the Water freed of Air till ten Days after it had been put in.

This Experiment drew another after it, to know whether the Water purged of Air were less fit than common Water to make Plants vegetate. For this End I took two Vials full, the one of Water purged, the other of common Water, and having put a Twig of Balm in each, I left them both in the Air. I found, that the Twig in the common Water shot at the end of 6 Days, and in Water purged shot this Time neither but ten Days after it had been put in.

I repeated this Experiment once more, and I was much surprized to see, that the Twig in the Water freed of Air begun this Time to shoot the 3^d Day, and the other in the common Water, still the 6th Day. But this was remarkable herein, that the Twig in the Water purged shot no more but one Root, which grew very long, and on the 9th Day only it began a little to shoot another, which lengthned but one Line in two Days, whereas the Twig in the common Water had then 9 or 10 Roots, which were all very long, having always lengthned five Lines or more in a Day.

Although this Experiment appear'd at first contrary to the precedent, yet it still confirmed the first Thought, to wit, that the Air which is mixed in common Water serves for Vegetation, considering the little Root which the Twig shot in the Water cleansed of Air.

After this, I made some Experiments upon harder Plants. One Day I put a green Piece of Sallow-Wood, part in the Air and part in Vacuo, after the Manner above describ'd. I put into Water that Part which was in the Air, and the Water presently began to mount and to pass through the Middle of the Wood, and incessantly formed Bubbles in the Receiver. These Bubbles continued thus for the Space of 24 Hours; and certainly it was the Water, which passing through the Wood, was in Part changed into Air. For I made the same Experiment with a Piece of Buffe, and the Water mounted also and passed through it, but it formed no Bubbles. Mean time, if there be Valves in Wood, they

they must needs be unable to resist the *Pressure* of the *Air*; for I have noted in *Sallow*, as well as in *Elm*, that the *Water* passes thro' them with the same Facility what End soever you put in *Vacuo*.

—One Day also I put the upper End of a little *Elm Branch* in the *Vacuum*, and the lower End in the *Air*. This lower End I trenched in *Water*, as I had done the *Roots* of *Balm* before: But it was a whole Hour before there appeared any Drop of *Water* upon the *Elm-Leaves* in *Vacuo*, whereas upon the *Balm-Leaves* the Drops appeared presently. The Cause of which may be the Hardness of the *Elm-Wood*. But I know not why *Water* passing thro' Wood forms *Bubbles*, and in passing thro' Leaves forms nothing but Drops.

I made also the Experiment the other Way, that is, the *Leaves* in the *Water* without the *Recipient*, and the lower End of the Branch in *Vacuo*, and I saw, that there passed nothing for 2 Hours time; insomuch that I cut a little of the upper End of the Branch which was very tender, and then indeed I saw a little Moisture appear at the End that was in *Vacuo*, but that enough only to form one Drop, and there appear'd no Bubbles of *Air*. Then I cut the Branch yet a little lower, and then there was formed one Drop of *Water* at the End that was in *Vacuo*, but it fell not. And having cut the Branch yet a little more, the Drop of *Water* fell down in *Vacuo*. This shews, that they were not the *Valves* of the *Plant* that hindred the *Water* from passing whilst the Branch was entire; but rather that it was the great Tenderness of the Leaves, suffering themselves to be compressed by the *Pressure* of the *Air*, and that so the *Water* could not insinuate it self between their Parts.

Apr. 3. 1673. * I included an *Apple*, which had a little Speck of *Rottenness*, and some *Water* in the same *Recipient*, thereby to promote the *Corruption*, in Case any should come to pass: But I have not found that any *Change* happen'd to it since that Time.

n. 121. p. 422.
* These Experiments were printed at Paris, in the Year 1674.

Jun. 7. I included in a *Receiver* two *Nossgays* of *Roses*, one suspended at the Top, the other having its Tail in a little Vessel full of *Water*. I also put in the same *Receiver* a Gage 4 Inches long, to know whether any *Air* would be there produced. Two Days after, I found my *Roses* a little wither'd, and the *Water* already risen to 8 or 10 Lines near the Top of my Gage; and after that the Changes of these *Flowers* became still less, so that at this present Time they are not much more wither'd, and the *Water* of the Gage is by 3 or 4 Lines nearer the Top. The *Roses* which lye dipt in the *Water* are as much wither'd as the others, and as soon. Other *Roses* which I had included at the same Time, but with *Air*, grow mouldy in less than 8 Days.

At another Time I included one single *Rose-Button* in a very little Glass, to learn whether it would keep its Scent. At the End of 15 Days it looked a little less fresh, but was not at all wither'd; and having taken it out, I found it had still its good Smell; but after that it lost both Colour and Smell, in less than two Hours. I must also add, that its Leaves did not appear moist in the *Vacuum*, but they looked all moist as soon as they were in the *Air*: Which shews, that the Parts of the Leaves had acted as Springs, like as *Sponges* do, and that the Weight of the *Air* coming to press upon them, did express

express the Humidity which had insinuated it self between the Parts thus expanded.

I did also include some *Gilly-Flowers*, which changed but very little; only they looked as if they had been dipped in Water.

Having included some *Strawberries*, at the End of 2 Days they look'd less fresh; but after that, seeing they changed no more, I took them out of the *Vacuum* after they had been there 15 Days. They had still the Smell and Taste of *Strawberries*; but they had also contracted a very ungrateful Taste of the Cement which I then employed to close them up with.

Vid. Sup.
§ LXXIV.

At another Time, I put some *Strawberries* without Cement, making use of a Skin, after the Manner described formerly, and I then observ'd nothing new, except that their Taste kept good, but was a little sourish, and that they yielded a little Water.

Jun. 24. I included some *Cherries*, to the Number of 25 or 30, in a *Receiver* which was almost fill'd with them. They all burst but 2. Two Days after they had a little chang'd their Colour, and those two that before remained whole, were now burst like the rest. After that, I observed no more change in them.

Jul. 20. I included in the *Vacuum* one *Cherry*, with eleven great *Currants*. The *Cherry* burst presently, and after that, I found it not changed, only it appear'd turned, as the *Currants* also did: This is a Beginning of Putrefaction, which may be imputed to the Air that remains in the *Receivers*.

Jul. 27. I included in the *Vacuum* four *Rasberries* and three *Currants*. The latter appear'd also to be turn'd, and the *Rasberries* looked less fresh than they were. But 'tis now more than five Months that I perceive no Change in them.

Hitherto I had employ'd none but *small Receivers*, which did just hold that little Fruit I put in them, and the *red Currants* seem'd to keep well enough; so that one Day I fill'd a great *Glass*, of the Figure of *cupping Glasses*, with them, hoping to keep that as well as the *small Receivers*. But I was surprized five Days after, to see that *Bubbles* were formed in the *Turpentine* which I had put about the said *great Glass* in the Place where 'twas fasten'd to its *Cover*, and that these *Bubbles* were burst outwards; and afterwards having seen that the *Cover* held fast to the *Bolt-head* no longer, I made no doubt of the *Currants* having produced Air enough to lift up the said *great Glass*, and to form in the *Turpentine* the *Bubbles* I had seen. I was confirm'd in this Thought, when I found by the Smell that they had fermented. They were yet good, except some that had lost almost all their Taste, and all their Acidity.

The same thing happen'd to me with a very *small Receiver*, that could hold no more but one *Cherry*, of that Kind we call *Bigarreaux*, and one *red Currant*. These Fruits yielded also Air enough to lift up their *Receiver* 7 Days after they had been included therein: And having reiterated this *Experiment*, I found the same Success; only this second Time the *Receiver* was not lifted up till the 11th Day. This Effect is rather to be ascribed to the *Cherry* than the *Currant*, because I have kept *Currants* to the Number of 11, in a *small Glass*,

Glass, and they did not raise it up. Whence it follows, that the *Bigarreaux* yield much more *Air* than acid Fruit.

Another Time I included some of the same Kind of *Cherries*, a whole great Glass full, and found, that from the second Day they had yielded *Air* enough to lift up the *Cover*. I took away part of the *Cherries*, and included the rest again.

This second Time they did not raise the Glass till the 8th Day. The *Cherries* looked fair, but they had lost much of their Taste, and afterwards they were spoiled in less than an Hour.

I did also one Day include three *Pears*, of that Sort we call *Rouffeletes*, in a like figur'd Glass, which could hold no more. They lifted up the Glass at the end of 5 Days, and they were not changed, only one of them was a little softer.

Another Time I put a *Peach* in such a Glass emptied of *Air* with a Gage to it; and I found, that the first 6 Hours the *Quick-silver* in the Gage was risen about an *Inch*. Yet it was not till the 13th Day that the Glass was lifted up; and the *Peach* appear'd to have kept very well till then; but after that, it rotted in a very little Time.

I did once put some *Bread* with a Gage, but I found not that for the Space of a whole Month it had yielded any *Air*, so that I took it out, and found it yet good; only it had a little taste of *Mustiness*, which yet appear'd not; at all to the Eye, and whereof the Cause may be ascribed to that little *Air* that might rest in the *Receiver*.

One Day I included a Piece of roasted Mutton with a Gage, and found, that in 4 Days it had yielded no *Air*, but after my Absence of 6 Weeks, I saw the *Mercury* was risen to the Middle of the Gage, and having taken out the Meat, I found it of a very ill Smell.

Two Days after, I included a Piece of raw Beef, and a Gage with it, and I saw, that in 2 Days the *Quick-silver* was risen an *Inch* in the Gage; and after 6 Weeks Absence, I found the *Mercury* was got almost to the Top of the Gage, and that this Meat had contracted a much worse Smell than that which had been roasted.

I also kept for 15 Days a Piece of fresh Butter in *Vacuo*, and I found, that it smelt more strong than when I first put it in: But yet it could be still eaten upon Bread, whereas another Piece of Butter, which at the same Time I had kept in the Air, was altogether unfit to be eaten.

One Day I covered a Receiver, whose 4th Part was fill'd with Water, and the rest all empty. I put it over the Flame of a Candle, and saw, that the Water boiled very quickly, yet the Glass not much heated; so that the Water boiled near a quarter of an Hour, with a great *Ebullition*, and the Glass was no more than tepid. I then took it away from the Flame, and saw that the Water continued a very great while boiling, and that it began again from Time to Time. I then believed that the Vapors which had been raised into the Air, were recondensed by the Cold, and that that made the hot Water bubble up, as Water usually doth when 'tis put into the Engine, and the Air that presses it exhausted. Mean Time, I have since made the Experiment with

with a Gage, and I did not perceive, that all the *Bubbles* that issued out of the Water made the *Mercury* rise to Sense.

After this, I left my *Receiver* exposed to the Frost, and I found that the *Ice* which was made therein was not yet quite free from *Bubbles*, though the Water thereof had boiled in the *Vacuum*, which one would think should have driven out all the Air; yet the *Bubbles* were there far less numerous than in *Ice* made of ordinary Water. I perceived not, that the *Quick-Silver* was much risen in the Gage. Afterwards I melted this *Ice*, and put the Water abroad to freeze again, still without taking it out of the *Vacuum*, and I found that this second Time it was very much freer from *Bubbles*. The Glass did not break; but because it was somewhat conical, we could not know, whether it remained whole upon the Account of its Figure, or because that the Water which was frozen within was freed of Air.

After this, I made *Spirit of Wine* boil in *Vacua* in the same Manner I did the Water, and I saw that it boil'd much sooner. It made the *Mercury* rise about an *Inch* in the Gage. Then I took it from the Fire, and saw it continue in its Boiling; and even sinking the *Receiver* into cold Water, it thereupon boiled much more strongly. One would think this proceeded from an *Antiperistasis*; but we have more ground to say it came from hence, that the Vapors of the Spirit were condensed, and so made the *Receiver* more empty; which is sufficient to make the Spirit of Wine boil, even tho' it were not hot. The *Quick-silver* did in two Hours subside again, to near half a Line as low as it had been. Then I put the *Receiver* over the Flame again, and made the *Mercury* rise more than two *Inches*; but then the *Receiver* cracked.

One Day I took a Tube of *Plaster of Paris*, open at one End, and close at the other. I applied the open End to the Cement as I was wont to do *Receivers*; and I saw it was not possible thus to exhaust it, because the Air did easily pass thro' the *Plaster*. I put therefore a Tube of Iron on the Engine, so as having fill'd it with Water, the Tube of *Plaster* was covered therewith; and then having caused the Pump to be plied, I found, that the Water did pass as easily thro' the said *Plaster*. I therefore covered it with *Venice-Turpentine* instead of Water, and then I saw that it evacuated very well, and that nothing pass'd thro' it for the Space of two Hours. Then I took some Oyl very hot, and poured it over the *Turpentine*, which did melt by this Heat, and pass'd thro' the *Plaster*. Then I took off this Tube, which was so pervaded by the *Turpentine*, and I saw, that that had made it transparent: Which effect is pretty like, and is to be explicated in the same Manner as that of the little Stone called *Oculus Mundi*. Thus we may be assisted by the Weight of the Air to make diverse Sorts of *Glues* penetrate *Plaster*, baked Earth, Wood, &c. And possibly those, who shall make a good Number of such Trials, will find their Labour and Pains recompensed, by giving to those Materials such Properties as they never had before.

I did also put some Eggs in the *Vacuum*, and one Day I saw one of them break, which I had put in a small *Receiver*. It burst upon the very first Suction: But since that Time I could never make any break, tho' I exhausted as much as I could

I could those *Receivers* wherein I had put some. You must therefore begin to crack them a little before you put them in the *Vacuum*, and then they do easily break quite, and what is in the Egg riseth all into a very thick *Froth*: I also put some of these thus ordered over the Fire, where they boiled very easily, not being pressed by the Air, but they boiled there very long, before it began to appear that they were so boiled as to be ready to eat.

All the little Bubbles that appear in *Mustard*, do swell and break in *vacuo*; and after that, the *Mustard* is seen to be without Bubbles.

One Day I included a *black Ribbon* in the *Vacuum*, and then burnt it with a *Burning-Glass*. Abundance of Smoke issued out of it, which fell by little and little, and so permitted us to see the *Ribbon* plainly; which appeared not at all changed. But after I had returned the Air into it, and touched it, I found it turn'd to Ashes.

Another Time I caused also some *Gunpowder* to be burnt after the same Manner; and I was much surprized to see that it burnt Grain by Grain, none of the Grains kindled firing those which touched. Another Time when the Sun had less Force, I could not at all kindle the Powder, but I made it only boil and emit Store of Smoke. I had put a Gage in the same *Recipient*, by means whereof I observ'd, that that Smoke produced no Air; for the *Quicksilver* did not rise in the Tube. I noted also, that this Smoke falling upon the Past-board, on which I had put the Powder, appeared yellow, of the Colour of *Brimstone*. After that, I took out the Powder that remained, being like a black Mass, and having put it upon burning Coals, I saw it burned as doth *Salt Petre*, and so it appeared, that the Sulphur was almost all exhaled. I was willing to reiterate this Experiment, and I then saw that the Powder after boiling, fuming, and being kindled Grain by Grain, (as in the first Experiment,) at last flashes out all at once, when one hath the Patience to hold the Fire to it with a burning Glass. And when the Fumes are grown clearer, you may see Needles of *Salt Petre* sticking to the sides of the *Receiver*.

Another Time, I put the Weight of 12 or 15 Grains of *Powder* in a Glass, shaped like a *Cupping-Glass*, capable to hold 14 Ounces of Water, and having put Fire to it, I made the Powder boil and smoke as usually. Afterwards, seeing that the Corns began to crack very near one after another; I then took away the burning Concave, for fear all should be kindled together: But it was already too late; for the Corns did continue to crack longer than a second of Time, and at last all kindled, tho' there was then nothing left to heat them but the Fire which they had kept within themselves. The *Receiver* was lifted up above a Foot high without breaking.

Another Time I put the Weight of 18 Grains of *Powder*, together with a Gage, into a *Receiver* holding 7 Pound of Water, and I saw, that the *Powder* was more difficult to be kindled, than in small *Receivers*. Yet at length it was kindled all together, and made the *Quick-silver* rise to the height of an Inch and a half in the Gage; and I am very well assured, that all that Air was not come from without; for that Part of the *Receiver*, to which the Cover is applied, had always been under Water.

From what I have been relating, it may be concluded, that there is a 5th Part of *Air* in *Gun-powder*, supposing, as other *Experiments* do shew, that *Air* is about a thousand Times lighter than *Water*. For, in this *Experiment*, the *Mercury* did rise to the 18th Part of the Height where the *Air* commonly sustains it; and consequently the Weight of 18 Grains of *Powder* did yield *Air* enough to fill the 18th Part of a *Receiver* that contains 7 Pound of *Water*. Now, this 18th Part contains 49 Drachms of *Water*: Wherefore, the *Air*, that takes up an equal Space, being 1000 Times lighter, weighs $\frac{1}{1000}$ of 49 Drachms, which is more than $3\frac{1}{2}$ Grains. It follows therefore, that the Weight of 18 Grains of *Powder* which I employed in my *Experiment*, contained more than $3\frac{1}{2}$ of *Air*, which is about the 5th Part of 18 Grains.

It may also be calculated, how many Times this *Air* hath been compressed in the *Powder*: But this Calculation is more uncertain than the former, because we know not, whether this *Air* took up more or less than the 5th Part of the Space which the *Powder* possessed. But yet 'tis certain, that tho' it had even taken up 3 Fourths of the whole Room of the *Powder*, and that the 14 Grains of the other Matter had taken up no more than the one remaining fourth Part, still this *Air* would have been compressed about three hundred Times. To calculate this, I suppose, that the space of a *Cubick Foot*, can hold only 72 Pounds of *Gun-powder*, which do contain more than 14 Pounds of *Air*, by the foregoing *Calculus*; which Quantity of *Air* is therefore found inclosed in the three Fourths of a *Cubick Foot*. Now, this space doth usually contain but about 6 Drachms of *Air*: Wherefore, to make it hold 14 Pounds of *Air*, which is near 300 Times six Drachms, it must needs be, that the *Air* be compressed near 300 Times.

There is Reason to believe, that this Compression is much greater, because a *Cubick Foot* can hold much more than 72 Pounds of *Powder*, and because also that the 5th Part of the Weight must not in Appearance possess alone the three Fourths, and all the rest take up no more than one Fourth of the Space possessed by all the *Powder*.

I should therefore make no difficulty to believe, that all the Effect of *Gun-powder* comes from the *Air* which is compressed therein, and especially in the *Salt Petre*; for I have not yet observed that *Brimstone* yields *Air*. Possibly also we may find in Time, that all other *Fulminations*, *Ebullitions*, and *Fermentations*, that make such surprizing Motions, are nothing else but *Air* compressed expanding it self.

n.122.p.542. One Day I included in the *Vacuum* an Insect which resembles a *Beetle*, but is a little bigger, and when I perceived it to appear dead, I gave it *Air* again, and it soon after recovered. Then I put it in the *Vacuum* again, and having left it there for an Hour, I readmitted the *Air*, and found, that then the Insect needed much more Time to recover. I included it there the third Time, and having left it there two Days, I gave it *Air* again, and saw it needed about ten Hours before it began to stir again; yet it recovered well enough this Time: But having put it in again the fourth Time, and left it there 8 Days, it would never stir again.

Intending

Intending to try the like upon a *Butterfly*, I saw, when I re-admitted *Air* to it, that the Top of its Back, which before was much swelled, did fall in more than it should, and the *Insect* would not recover.

I also killed in the *Vacuum* many Animals that breath, as *Birds*, *Mice*, *Rats*, *Rabbits*, *Cats*; and some of them I recovered by quickly giving them *Air* again before the *Engine* was quite exhausted; but I never saw any of them *Revive*, that had been in a perfect *Vacuum*.

M. Guide did make frequent *Dissections* of such Animals as we had thus kill'd, and observed, amongst other Things, that their *Lungs* fell to the bottom in *Water*. He saith, that the *Solidity* or *Closeness* of the *Lungs* of Animals, that have died in *Vacuo*, comes from hence, that the *Blood* which is propelled into the *Lungs* by the *Vena Arteriosa*, doth so strongly press the *Bronchi* of the *Arteria aspera*, that it expresses the *Air* out of them, and glues as 'twere their sides to one another. But for my part, I do not believe, that the *Blood* of the *Vena Arteriosa* can thus compress those *Bronchi*, because that the said *Blood* is inclosed in its Vessels, that keep and hinder it from compressing others. Yet I am not ignorant, that the Things that are included in the *Oesophagus* do indeed compress the *aspera Arteria*, and that the *aspera Arteria* by being filled compresses also the *Oesophagus*, upon the account of the Situation of these two *Conduits*. But it appears not at all, that the smallest *Ramifications* of those *Bronchi*, and of the *Vena Arteriosa*, are situate in the same Manner; for the *Bronchi* being harder than the *arterial Vein*, they will compress it more easily, than be compressed by it; and so if you should blow them up with Bellows, they would glue the Sides of that Vein together, and hinder the Circulation: Which is directly contrary to the Experiment, as M. Guide himself observeth.

It is therefore far more probable, that if the *Lungs* be compressed, that Compression is made by the *Pleura*, which may be swelled within the *Breast*, as the *Skin* is swell'd without. But it is not necessary that the *Lungs* be compressed in *vacuo* to make them subside in *Water*; for I have diverse Times put pieces of *Lungs*, and whole *Lungs* in the *Vacuum*, and they remained there extremely swell'd; but as soon as the *Air* was again intromitted, they became very flat and red, and sunk to the bottom in *Water*. Which shews, that 'tis sufficient for getting the *Air* out of the *Lungs* to render them close and red; and I have not been able to produce this Effect but by means of the exhausting Engine. For I have left *Lungs* a whole Night between two Plates, with a great Weight upon them, to endeavour to press the *Air* out of them, but it would not succeed, and those *Lungs* did still float upon the *Water*. I have also tried to make the *Air* re-enter into the *Lungs*, after I had render'd them solid in the Engine, and that I found very easy; for drawing them out from the bottom of the *Water*, I did blow into the *Aspera Arteria*; and the *Lungs* swelled again, and resumed their ordinary Colour, and floated on the *Water*. And this is that which befalls the *Lungs* of *Infants* new born.

LXXX. I seal'd up a round Glass hermetically, and covered it with a double *Bladder* very carefully, and including it in a large Receiver, I found

A Pneumati-
cal Experi-
ment, by M.
Joh. Chr.
Sturmius,
Ph. Coll. n.
2. p. 8.

according to my Expectation; that after about 200 *Exhaustions* had been made, it broke all in Pieces with a very great noise.

LXXXI. Papers, Of less general Use, omitted.

- n.251.p.144. 1. **A** List of the *French Academicians* at their new Regulation in the Year 1699. by M. Geoffry.
- n.99.p.6158. 2. An Account of some of the *natural Things*, with which the intelligent and inquisitive Signior *Paulo Boccone*, of *Sicily*, hath lately presented the R. S. and enriched their Repository.
- n.246.p.393. 3. Remarks by Mr. *Ja. Petiver*, on some *Animals, Plants, &c.* sent to him from *Maryland*, by the Reverend Mr. *Hugh Jones*.
- n.255.p.295. 4. A Catalogue of *Shells, &c.* gathered at the *Island of Ascension*, by Mr. *Ja. Cunningham* Chirurgion, with what Plants he there observed; communicated to Mr. *Ja. Petiver*.
- n.246.p.390. 5. An Account of a *China Cabinet*, filled with several Instruments and some
n.247.p.461. *natural Curiosities* of that Country, sent to the R. Society, by Mr. *Buckley*,
n.249.p.44. chief Chirurgion at Fort St. George; by *Hans Sloane*, M.D.
n.250.p.70. 6. A *Thermoscope* and a *Baroscope*, invented by Mr. *R. Boyle*, described by
n.10.p.167. Dr. *Wallis*.
- n.13.p.218. 7. Dr. *Hook's Wheel Barometer*, describ'd in his *Micrography*, is here something improv'd; by himself.
- n.91.p.5168. 8. *Experiments* propos'd, to explicate the Reason of the *Suspension* of *Mercury* in the *Torricellian Tubes* at an unusual Height; by Dr. *Wallis*.
- n.206.p.998. 9. Some *Queries*, concerning the Nature of *Light* and *Diaphanous Bodies*; by Mr. *Edm. Halley*.
- n.79.p.3060. 10. *Queries* concerning the different Effects of the *Sun's Heat* collected by a burning Concave, and that of *Fire*, upon *Gold, &c.* by P. Fr. *Luna*.
- n.66.p.2020. 11. An *Experiment* concerning the Progress of *artificial Conglaciacion*, and the remarkable Accidents therein observed; by the *Florentine Philosophers*, and published in their *Saggi di Naturali Esperienze*.
- n.23.p.424. 12. Proposals to try the Effects of the *Pneumatical Engine*, exhausted in *Plants, Seeds, Eggs of Silk-worms, &c.* by Mr. *R. Boyle*, and Dr. *Beale*.

LXXXII. Accounts and Emendations of Books, omitted.

- n.27.p.501. **T**HE History of the *Royal Society of London*, for the Advancement of
Experimental Philosophy; by *Theo Sprat*.
- n.36.p.715. 2. The Progress and Advancement of *Knowledge* since the Days of *Aristotle*, in an Account of some of the most remarkable late *Improvements* of useful Learning; by *Jes. Glanvill Lond.* 1668, in 8^{vo}.
- n.8.p.145. 3. A Narration of the Establishment of the *Lyncei*, an *Italian Academy*, and of their *Design* and *Statutes*.
- n.203.p.886. 5. *Diogenes Laertius*, *Græce & Latine*, cum commentariis integris Doctorum Virorum. *Amstel.* 1692.
- n.194.p.535. 6. *C. Plinii Historia Naturalis*. Notwithstanding the great Care of R. P. *Har-*
duine

duine, in this curious Edition, yet he hath past over several Faults; three of which Mr. Halley hath here corrected, viz.

1. Lib. 2. Cap. 13. Defectus [Solis & Lunæ] Ducentis Viginti Duobus Mensibus redire in suos Orbes certum est: Whereas it ought to be CCXXIII; at which Time that Period is compleated; and the Moon returns to the Sun and to the same Node accurately enough, to her Apogæum very near, and within a few Degrees to the same Place of the Heavens.

2. Lib. 11. Cap. 37. Jecur maxime vetustatis patiens centenis durare Annis Obsidionum exempla prodidere; which Mr. Halley conjectures should either be Hoc Seniorum exempla, or Hoc Syrorum exempla prodidere.

3. Lib. 20, Cap. 14. Instead of Syriation & vomicas vulvæ curavit illa, Mr. Halley reads Satyriafin & Vomicas vulvæ curavit.

7. Pinax rerum Naturalium Britannicarum, continens Vegetabilia, Animalia, & Fossilia, in hac Insula reperta. Auth. Chr. Merret. M. D. n. 20. p. 364.
n. 24. p. 448.

8. Museo Cospiano annesso a quello del famoso Uliße Aldrovandi, & donato alla sua Patria dell' Illustrissimo Signore Ferdinando Cospi Patricio di Bologna & Senatore, &c. Descrizione di Lorenzo Legati Cremonese. In Bologna 1678 in Fol. n. 140. p. 1011.

9. Musæi Petiveriani Centuria Prima; Rariora Naturæ continens: viz. Animalia, Fossilia, Plantas, ex variis Mundi plagis advecta; ordine digesta: Nominibus propriis signata; & Iconibus Æneis eleganter illustrata. Lond. 1696. in 8^{vo}. n. 224. p. 393.

10. 1. Saggi di Naturali Experienze, fatte nell Academia del Cimento, in Firenze, An. 1667. in Fol. n. 33. p. 640.

2. Essays of natural Experiments made in the Academy del Cimento under the Protection of the most Serene Prince Leopold of Tuscany. Establish'd by the ingenious Rich. Waller, Esq; 1684. in 4^{to}. n. 164. p. 757.

11. 1. Miscellanea Curiosa Medico-Physica, Academiæ naturæ curiosorum, Annus Primus, Lipsiæ 1670. in 4^{to}. n. 68. p. 2070.

2. Annus Secundus; Anni Scil. 1671. Jenæ, 1671, in 4^{to}.

3. Ephemeridum Medico-Physicarum Germaniæ Annus Tertius, &c. Lipsiæ & Francofurti. 1673, in 4^{to}. n. 85. p. 5624.
n. 101. p. 15.

4. Annus IV. & V. Anni 1673 & 1675, &c. Cum Appendice. Francofurti & Lipsiæ 1676. in 4^{to}. n. 129. p. 742.

12. 1. Thomæ Bartholini Acta Medica & Philosophica Hafniensia An. 1671 & 1672. Hafniæ. 1673 in 4^{to}. n. 97. p. 6135.

2. An. 1673. Hafniæ. 1675. n. 114. p. 315.

13. Georgii Hieronymi Velschii Hecatostæ 2. Observationum Physico-Medicarum Augustæ Vindelicorum. 1675. n. 127. p. 673.

4. Stephani Chauvini Lexicon Rationale, sive Thesaurus Philosophicus, &c. Roterodami. 1692. in Folio. n. 199. p. 731.
A

14. 1. Collegium Experimentale sive Curiosum, in quo Primaria hujus Seculi inventa & Experimenta Physico-Mathematica, A. 1672. quibusdam Naturæ Scrutatoribus spectanda exhibuit, & ad Causas suas Naturales demonstrativa Methodo reduxit, Jo. Christophorus Sturmius Norimbergæ. 1676 in 4^{to}. n. 121. p. 509.

2. Pars Secunda. Altorfi. 1685. in 4^{to}. n. 175. p. 1184.

- n.92.p.6001. 15. *Experienze intorno a diverse Cose Naturali, & particolar mente à quelle che ci son portate dall' Indie; fatte da Francesco Redi in Firenzi. 1671. in 4^{to}.*
- n.207.p.33. 16. *Observationi Naturali, ove si contengono materie Medico Fisiche, &c. Natural Observations, containing several Medico-Physical, and botanical Matters; with diverse natural Productions; several Sorts of Phosphori, subterraneous Fires in Italy; and other curious Subjects; in familiar Letters, by Signior Paul Boccone. M.D. Bononia, 1684, in 12^{mo}.*
- n.207.p.37. 17. *Museo di Fisica, & di Esperienze, arricchito di Figure di Piante Nove*
n.249.p.53. *Offervazione, Note Medicinali e Ragionamenti, secondo i Principii di Neoterici, disposto in Decade VIII. by S. Paolo Boccone. Upon this Book Mr. Ray adds here some Remarks of his own.*
- n.73.p.2214. 18. *Philosophus Autodidactus, exhibitus in Epistola, ex Arabica in Latinam Linguam versa, ab Edvardo Pocockio; Oxon. 1671 in 4^{to}.*
- n.69.p.2114. 19. *Prodromo Overo Saggio di alcune Inventioni noue premesso all' Arte Maestra, di P. Francisco Lana S.I. in Brescia, 1670. in 4^{to}.*
- n.72.p.2179. 20. *Of the Usefulness of experimental natural Philosophy, the second Tome; by the honourable Robert Boyle, Esquire, Oxon. 1671. in 4^{to}.*
- n.103.p.53. 21. *About the Excellency and Grounds of the Mechanical Hypothesis, some Considerations occasionally proposed to a Friend, by R. B. E. Lond. 1674. in 4^{to}.*
- n.181.p.116. 22. *A free Enquiry into the vulgarly receiv'd Notion of Nature; by the Hon. R. Boyle, Esq; Lond. 1686. in 8^{vo}.*
- n.40.p.810. 23. *Ren des Cartes Epistolæ; Pars Prima & Secunda. Lond. 1668. in 4^{to}.*
- n.22.p.392. 2. *Le Tome Troisième & Dernier des Lettres de M. des Cartes.*
- n.54.p.1094. 24. *Le System General de la Philosophie; per Francois Bayle. D.M. a Tholouze, 1696. in Fol.*
- n.62.p.2034. 25. *A Discourse in Vindication of Des Cartes's System; by Mr. Des Fournellis: To which is annexed, the System General of the same Cartesian Philosophy, by Francis Bayle, Lond. M. D. 1670.*
- n.70.p.2137. 26. *Philosophia Veterum, è Mente Renati des Cartes breviter digesta; ab Antonio le Grand. Lond. 1670. in 12^{mo}.*
- n.80.p.3094. 27. *Antonii le Grand institutio Philosophiæ, secundum Principia Renati de*
n.108.p.192. *Cartes, nova Methodo adornata, & explicata, Lond. 1672. in 8^{vo}.*
- n.94.p.6046. 28. *Antonii le Grand Historia Naturæ. Lond. 1673. in 8^{vo}.*
- n.123.p.579. 29. *De consensu Vet. & Novæ Philosophiæ, Lib. 4. seu Promotæ per Experimenta Philosophiæ pars prima: Auth. J. B. du Hamel. P. S. L. in 12^{mo}.*
- n.65.p.2105. 30. 1. *De Corporum Affectionibus cum manifestis tum occultis, Libri 2 seu Promotæ per Experimenta Philosophiæ Specimen, Auth. J. B. du Hamel, Paris, 1670. in 12^{mo}. Mr. Boyle's Discourse (in his Origin of Forms and Qualities,) concerning the Necessity of the Creator's Concourse in the Preservation of all Things, being misunderstood by Mr. du Hamel, is here explained.*
- n.98.p.6151. 2. *De Corpore Animato, Libri 4. seu Promotæ per Experimenta Philosophiæ Specimen alterum: Auth. Job. Baptista du Hamel. P. S. L. Parisiis, 1673. 12^{mo}.*
- n.131.p.790. 31. *Clavis Philosophiæ Naturalis, Aristotelica Cartesiana; Editio secunda, aucta Opusculis Philosophicis varii Argumenti; quibus Errores Scholarum passim deteguntur. ac veritas Philosophiæ, quam Cartesianam vocant, confirmatur, Auth. Jo. de Raai. Amst. 1677. in 4^{to}.*

32. *Elementa Physica, five nova Philosophiæ Principia*; ubi *Cartesianorum* Principiorum Falsitas ostenditur, ipsiusque Errores ac Paralogismi ad Oculum demonstrantur ac refutantur; a *Fran. Willhelmo* Libero Barone de Nuland, &c. *Hagæ Comitum*, 1669. in 12^{mo}. n.65.p.2007
33. *Placita Philosophica Guarini*.
34. *Physica in Decem Tractatus Distributa*; Auth. *Honorato Fabri* S. J. *Lugd. Gal.* 1669 in 4^{to}. n.20.p.365
35. *Honorati Fabri*, S. J. Tractatus duo; quorum Prior est de *Plantis* & de *Generatione Animalium*; Posterior de *Homine*. n.68.p.208a. n.18.p.325.
36. *Traite de Physique* par *Jaques Robault*, a *Paris* 1671. in 4^{to}.
37. *Propositiones Hydrostaticæ ad Illustrand. Aristarchi Samii Systema definitæ*, & quædam *Phænomena Naturæ* generalia. Auth. *Francisco Jessop* Arm. *Lond.* 1687. in 4^{to}. n.70.p.2138 n.191.p.440.
38. *Casp. Bartholini* Thom. F. *Specimen Philosophiæ Naturalis*. Accedit de *Fontium, Fluviorumque Origine* Dissertatio Physica. *Amstelodam.* 1697. in 12^{mo}. n.237.p.62a.
39. *Thomæ Cornelii Consentini* Progymnasmata Physica. n.30.p.576.
40. *Les Essais Physiques* du *Siure de Launay*.
41. *Erasmi Bartholini* de *Naturæ Mirabilibus Quæstiones Academicæ*. *Hafniae*, 1674. in 4^{to}. n.30.p.579.
42. *Decameron Physiologicum: Or ten Dialogues of natural Philosophy*. To which is added the Proportion of a strait Line, equal to half the Arch of a *Quadrant*. By *Mr. Hobbs*. n.107.p.159 n.138.p.965.
43. *Cosmopœia Divina, seu Fabrica Mundi explicata*, per *Ludov. de Beaufort*. M.D. *Lugd. Batav.* 1656. in 4^{to}. n.59.p.1052.
44. *Cartesius Mosaizans*; Auth. *Joh. Amerpoel* *Leowardiæ* 1669. in 12^{mo}. Ibid.p.1053.
45. *The Divine History of the Genesis of the World*, explicated and illustrated, *Lond.* 1670. in 4^{to}. n.60.p.1083.
46. *A Treatise of the Bulk and Selvage of the World, &c.* by *Nath. Fairfax* M. D. *Lond.* 1673. n.93.p.6172.
47. *Telluris Theoria sacra*. Authore *T. Burnetio*. *Lond.* 1681. in 4^{to}. PhCol.3.p.75
48. *Archeologiæ Philosophicæ, five Doctrina Antiqua de Rerum Originibus*; Libri duo. Auth. *Tho. Burnet*. *Lond.* 1692. n.201.p.769.
49. *Considerations on a Book Entitled, the Theory of the Earth: Published some Years since by the Learned Doctor Tho. Burnet*. Written by *Jo. Burnet*, Jun. *Gent.* n.203.p.888.
50. *The Wisdom of God manifested in the Works of the Creation*, in 2 Parts. By *Mr. J. Ray*. *Lond.* 1692. in 8^{vo}. n.196.p.611.
51. Three Physico Theological Discourses, concerning, 1. *The Primitive Chaos, and Creation of the World*. 2. *The General Deluge, its Causes and Effects*. 3. *The Dissolution of the World*, by *Mr. J. Ray*. *Lond.* 1693. in 8^{vo}. Ibid. p. 615.
52. *The Prodromus of a Dissertation concerning a Solid contained in a Solid*, by *Nicolaus Steno*. *English'd out of Latin*. *Lond.* 1671. in 8^{vo}. n.72.p.2186.
53. *An Essay toward a natural History of the Earth, and terrestrial Bodies, especially Minerals: As also of the Sea; Rivers and Springs*. With an Account of the *universal Deluge*, and of the Effects it had upon the *Earth*. By *J. Woodward*, M.D. *Lond.* 1695. in 8^{vo}. n.217.p.215.

- n. 119. p. 181. 199. 54. *La vana speculatione disingannata dal senso: Lettera responsiva circa i Corpi Marini, che Petrificati si travano in varii Luoghi Terrestri. Di Agostino Scilla Pittore Academico della Fucina, in Napoli, 1670 in 4^{to}. This Book is here Abridg'd, some short Notes added, and some of the Author's Figures annexed and explained by two of the Fellows of the Royal Society.*
- n. 8. p. 145. n. 11. p. 191. 55. 1. The Origin of *Forms* and *Qualities* illustrated by Considerations and Experiments; by the Hon. Robert Boyle Esq;
- n. 66. p. 2044. 2. The same in *Latin*. Oxon 1669 in 12^{mo}.
- n. 28. p. 532. 56. Free Considerations about *subordinate Forms*; by the Hon. Rob. Boyle.
- n. 63. p. 2057. 57. Tracts written by the Hon. Rob. Boyle, about the *cosmical Qualities* of Things; the Temperature of the *subterranean* and *submarine Regions*; and the Bottom of the Sea; together with an Introduction to the History of particular Qualities. Oxon. 1670. in 8^{vo}.
- n. 127. p. 669. 58. Experiments, Notes, &c. about the *Mechanical Origin* of diverse particular Qualities: Among which is inserted a Discourse of the Imperfection of the Chymists Doctrine of Qualities; together with some Reflections upon the Hypothesis of *Alcali* and *Acidum*. By the Hon. Rob. Boyle, Esq; Lond. 1675. in 8^{vo}.
- n. 130. p. 766. 59. Roberti Boyle Nobilissimi Angli & Soc. Regiæ dignissimi Socii, Opera varia, Geneva. 1677. in 4^{to}. This Edition and Translation is here complained of for several Reasons.
- n. 53. p. 1069. 60. Certain *Philosophical Essays*, and other Tracts, by the Hon. Rob. Boyle.
- n. 162. p. 702. 61. Experiments and Considerations about the *Porosity* of Bodies, in two Essays; by the Hon. Robert Boyle Esq; Lond, 1684. in 8^{vo}.
- n. 96. p. 6101. 62. Several Tracts written by the Hon. Rob. Boyle, of the strange Subtlety, Efficacy, and determinate Nature of *Effluvia*; of new Experiments to make the Parts of Fire and Flame stable and ponderable; together with some additional Experiments about Arresting and Weighing of *igneous Corpuscles*; as also a Discovery of the *Perviousness* of Glass to ponderable Parts of Flame, with some Reflections on it by way of Corollary.
- n. 150. p. 982. 63. An Essay of the great Effects of even *Languid* and *unheeded Motions* Lond. 1685.
- n. 1. p. 8. n. 3. p. 46. 64. New Observations and Experiments in Order to an *experimental History* of Cold, by the Hon. Rob. Boyle Esq.
- n. 78. p. 3043. 65. *Dissertations sur la Nature du Froid & du Chaud, par le Sieur Petit Avec un Discours sur la Construction & l'Usage d'un Cylindre Arithmetique invente par le mesme Auteur, a Paris, 1671.*
- n. 267. p. 724. 66. *Thaumantiadis Thaumasia, sub Præsidio Dom Chr. Sturmii. Noriberge, 1699.*
- n. 42. p. 845. 67. A Continuation of new Experiments *Physico-Mechanical*, touching the Spring and Weight of the Air, and their Effects; the I. Part, &c. by the Hon. Rob. Boyle, F. R. S. Ox. 1668. in 4^{to}.
- n. 50. p. 1017. 68. *Georgii Sinclarii Ars Nova & Magna Gravitatis & Levitatis. Roterodami. 1669. in 4^{to}.*
- n. 92. p. 5199. Some Complaints and Suggestions by that Author, (in his Preface) are here answer'd.

69. Dimostrazione Fisico-Matematica Delle sette Propositioni, che promette *Donato Rosetti*, in Firenze 1668. in 4^{to}. n. 65. p. 213.

70. Observations touching the *Torricellian Experiment*, and the various Solutions of the same, especially touching the *Weight* and *Elasticity* of the *Air*. Lond. 1674. in 8^{vo}. n. 104. p. 78.

71. Tracts written by the Hon. *Rob. Boyle*, of a Discovery of the admirable *Rarefaction* of the *Air* (even without *Heat*;) New Observations about the *Duration* of the *Spring* of the *Air*; New Experiments touching the *Condensation* of the *Air* by mere Cold; and its Compression without *Mechanical Engines*: And the admirably differing *Extension* of the same Quantity of *Air* rarified and compressed. Lond. 1670. in 4^{to}. n. 67. p. 2059

72. Tracts, written by the Hon. *Rob. Boyle*, containing new Experiments touching the Relation betwixt Flame and Air, and about Explosions: An Hydrostatical Discourse, occasion'd by some Objections of Dr. *Hen. More*, &c. To which is annexed an Hydrostatical Letter, about a Way of weighing Water in Water: New Experiments of the *Positive* or *Relative Levity* of Bodies under Water; of the *Air's Spring* on Bodies under Water; and about the differing Pressure of heavy *Solids* and *Fluids*. Lond. 1672. in 8^{vo}. n. 92. p. 5197

73. Tracts, consisting of Observations about the *Saltness* of the *Sea*: An Account of a *Statical Hygroscope* and its Uses; together with an Appendix about the Force of the *Air's Moisture*: And a Fragment about the *Natural* and *Præternatural State* of Bodies, by the Hon. *Rob. Boyle*. To all which is premised a *sceptical Dialogue* about the *positive* or *privative* Nature of Cold: By a Member of the *R. Society*. Lond. 1673. in 8^{vo}. n. 97. p. 6127

74. Tracts, containing, 1. Suspicions about some hidden Qualities of the *Air*, with an Appendix touching *celestial Magnets* and some other Particulars. 2. Animadversions upon M. *Hobb's Problemata de Vacuo*. 3. A Discourse of the Cause of *Attraction* by *Suction*: By the Hon. *Rob. Boyle*, Esq; Lond. 1674. in 8^{vo}. n. 110. p. 226.

75. A Discourse concerning the Origin and Properties of Wind, &c. by *R. Bobun*. Oxon. 1671. in 8^{vo}. n. 90. p. 514.

76. Aero-Chalinos, or a Register for the Air, &c. by *Nath. Henshaw*. M. D. Lond. 1677. in 12^{mo}. n. 133. p. 834

C H A P. II.

Hydrology.

I. TAKE a Globe of Fir or Maple, or other light Wood, as *A*. let it be well secured by Varnish, Pitch, or otherwise, from Imbibing Water; then take a Piece of Lead, or Stone, *D*, considerably heavier than will sink the Globe: Let there be a long Wire Staple *B*, in the Ball *A*, and a springing Wire *C*, with a bended End *F*, and into the said Staple, press in with your Fingers the springing Wire on the bended End: and on it hang the Weight *D*, by

Vol II. L 1

To sound the
Depth of the
Sea without
a Line; by
Dr. Hook.
n. 9. p. 147.
n. 24. p. 499

Fig. 45. *D*, by its Hook *E*, and so let Globe and all sink gently into the Water, in the Posture represented in the *Figure*, to the Bottom, where the Weight *D*, touching first is thereby stopt; but the Ball, being by the Impetus it acquired in descending carried downwards a little after the Weight is stopt, suffers the springing Wire to fly back, and thereby sets it self at Liberty to re-ascend. And by observing the Time of the Ball's Stay under Water which may be done by a Watch, having Minutes and *2ds*; or by a good Minute Glass; or best of all by a Pendulum, vibrating seconds; the which must be three Foot, three Inches, and one fifth of an Inch long, *viz.* between the Middle of the Bullet, and the upper End of the Thread, where it is fastened, or held when it vibrates, you may, with the Help of some Tables, come to know any *Depth* of the *Sea*.

Note, That Care must be had of proportioning the Weight and Shape of the Lead, to the Bulk, Weight, and Figure, of the Globe, after such a Manner, as upon Experience shall be most convenient.

In some of the Tryals already made with this *Instrument*, the Globe being of Maple-wood, well covered with Pitch, to hinder soaking in, was $5\frac{1}{4}$ Inches in Diameter, and weighed $2\frac{1}{2}$ Pounds; the Lead, of $4\frac{1}{2}$ Pounds Weight, was of a *Conical*, (but is now used of a *Globous*) Figure 11 Inches long, with the sharper End downwards, $1\frac{1}{2}$ at the Bottom in Diameter. And in those Experiments made in the *Thames*, in the Depth of 19 Foot Water, there passed between the Immerfion and Emerfion of the Globe, 6 Seconds of an Hour; and in the Depth of 10 Foot Water, there passed $3\frac{1}{2}$ Seconds or thereabouts.

In the same Tryals it was also found, that there was no Difference in Time, between the Submersions of the Ball at the greatest Depth, when it rose two Wherry's Length from the Place where it was let fall, being carried by the Current of the Tide, and when it rose only a Yard, or so, from the same place where it was let down: And that it must be so in great Depths and stronger Currents, is as certain, as easy to be demonstrated.

And if it be alledged, that it must be known, when a light Body ascends from the Bottom of the Water to the Top, in what Proportion of Time it rises; it may be considered, that in this Experiment the Times of the Descent and Ascent are both taken and computed together; so that, for this Purpose, there needs not the Nicety which is alledged.

Of other Experiments of this way of *sounding* without a *Line*, made by the noble Lord *Viscount Brounker*, Sir Robert Moray Knight, and Mr. Hook, in the Chanel at *Sheerness*; the following Account was given; *viz.*

	Ounces,	Grains.
A wooden Ball <i>A</i> weighed	$52\frac{2}{3}$	00
Another wooden Ball <i>B</i> ,	30	22
A Lead <i>A</i>	30	00
Another Lead <i>B</i> ,	$30\frac{1}{4}$	00

The Ball *B*, and the Lead *B*, were let down at 16 Fathom; and the Ball returned in 48 single Stroaks of a *Pendulum*, held in the Hand, vibrating 58 single Stroaks in a Minute.

A second Time repeated with the same Success; therefore the Motion was 4 Foot every second.

Again, the Ball *A*, and the Lead *B*, whose Nail was bended into a sharper Angle; the Ball returned in 39 Stroaks. A second Time repeated with the same Success at the same Depth:

Ball *B*, Lead *B*, in which Tryal the Line not being clear, stopped a little the Motion; the Ball returned in 47 at the same Depth.

Ball *A*, Lead *A*, at 8 Fathom and 1 Foot, returned at 20; repeated at 8 Fathom, returned at 19.

Tried the *third* Time at 10 Fathom and 4 Foot, returned at 28.

A *fourth* Tryal, at the same Depth, just the same.

At a *fifth*, at 10 Fathom 5 Foot, returned at 27.

A *sixth* Tryal just the same.

A *seventh* at 12 Fathom 5 Foot, returned in 37.

An *eighth* Tryal just the same.

Another Day near the same Place.

Note, That the *Pendulum* was this Day adjusted, and made a little shorter, there having been but 58 *Vibrations* in a Minute the other Day.

Ball *A*, Lead *B*, at 14 Fathom, returned in $32\frac{1}{2}$.

A second Tryal, a little after, in the same place, returned in 33. In the making of which Trial, the *Vibrations* were told aloud, and the Lead having been let down by a Line, was found to touch the Bottom in just half the Time the Ball staid under Water. By a second Tryal, the ascending and descending was found to be in equal Times. And by a third Tryal, with another Lead, the very same found, *viz.* $16\frac{1}{2}$ descending, and $16\frac{1}{2}$ ascending. This Lead and Ball let down without a Line, the Ball returned in 13 *Vibrations*; a Sign it went not to the Bottom.

A Tryal made with a Lead, whose iron Crook was fastned at the Top of *Fig. 46.* it, succeeded very well, and the Ball returned in $34\frac{1}{2}$: But by reason of the Current, the Experimenters could not perceive, when the Lead touched the Bottom. This Lead being let down without a Line, the Ball returned in $32\frac{1}{2}$. The Depth of Water was now found by the Ship's Lead, to be 14 Fathom.

Another Tryal was made with a Line, bowing the Point of the Lead, and the Ball returned in 34. The same let down without a Line, the Ball returned in 6 or 7 *Vibrations*; a Sign again it went not to the Bottom. In a Tryal with another Lead, the Ball returned in 34. Repeated again with the same Success. *Fig. 47.*

In a Tryal with a Lead, whose Nail was set awry, the Ball returned in 34. *Fig. 48.* After which Tryal the Depth was found to be just 14 Fathom. The last Lead and Ball being let down without a Line, the Ball returned at 35. In another Tryal with a Lead that never failed, the Ball returned in 34, and the Lead touch'd the Bottom at 17.

By a 1st ryal with another Lead, the same Time was found exactly.

By a 3^d Tryal with this last, the very same.

These Tryals were made near about high Water, at the Depth of 14 Fathoms just by Measure; and in them, the Motions seem to be 5 Foot every Second.

In all these Tryals, the greatest Difficulty was, in the Use of Conical Figures, with Iron Crooks, to bend the Iron that it might be sure to carry down the Ball with it to the Bottom, and when come thither, to let it go: For almost every one of these Leads failed in one of these Requisites, till by several Tryals they had been adjusted.

It is not to be omitted, That the last Tryals being made near High-water, the Ball was found to rise (by the Boat being permitted to drive) far off upon one Side, out of the way, that any light Thing, suffered to swim on the Water, would be carried; which seemed to argue a Motion of the Underparts of the Water, differing from that of the Upper (a thing which is said to be at certain Times of the Tides, both at the Mouth of the Sound, and of the Streights; which deserves to be farther inquired into.) The Angle made by these different Motions, seemed to be about 40 gr.

To fetch up
Water from
any Depth;
By Dr. Hook.
n. 9. p. 149.
n. 24. p. 447.
Fig. 49.

II. Let there be made a square wooden Bucket *C*, whose Bottoms *E E*, are so contriv'd, that as the Weight *A* sinks the Iron *B*, to which the Bucket *C*, is fastened by two Handles *D D*, on the End of which are the moveable Bottoms, or Valves *E E*, and thereby draws down the Bucket; the Resistance of the Water keeps up the Bucket in the Posture *C*, whereby the Water hath, all the while it is descending, a clear Passage through; whereas, as soon as the Bucket is pulled upwards by the Line *F*, the Resistance of the Water to that Motion, beats the Bucket downward, and keeps it in the Posture *G*, whereby the included Water is kept from getting out, and the ambient Water kept from getting in.

By the Advantage of this Vessel; you may come to know the Constitution of the Sea-water in several Depths; and whether it be saltier at and towards the Bottom.

Direction for
observing
Tides; By Sir
Rob. Moray.
n. 17. p. 298.

III. 1. To observe in what Proportion the Increases of the Tides from the Neap to the Spring Tides, and their Decreases, and the Risings and Fallings of the Ebbs, happen to be in Regard of one another. It is supposed upon some Observations, made by Sir Rob. Moray (though not thoroughly and exactly performed,) that these Increases are in the Proportion of Sines; the first Increase exceeding to the lowest in a small Proportion; the next in a greater; the 3^d greater than that; and so on to the Midmost, whereof the Excess is greatest, diminishing again from that, to the highest Spring Tide; so as the Proportions before and after the Middle, do greatly answer to one another, or seem to do so.

2. To observe the Increase and Decrease of the Velocity of the Current; which is also supposed to be according to the Proportion of Sines.

3. The

3. The exact Measures of the Heights of every utmost High-water and Low-Water from one Spring-Tide to another.

4. The exact Heights of Spring-Tides and Spring-Ebbs.

In Order to all which this following *Apparatus* is proposed to be made Use of. In some convenient Place upon a Wall, Rock, or Bridge, &c. Let there be an *Observatory* standing as near as can be to the Brink of the Sea, or upon some Wall; and if it cannot be well placed just where the low Water is, there may be a Chanel cut from the Low-water to the Bottom of the Wall, Rock, &c. The *Observatory* is to be raised above the High-water 18 or 20 Foot, and a Pump of any reasonable Dimension, placed perpendicularly by the Wall, reaching above the High-water as high as conveniently may be. Upon the Top of the Pump a Pulley is to be fastened, for letting down into the Pump a Piece of floating Wood, which as the Water comes in, may rise and fall with it. And because the rising and falling of the Water amounts to 60 or 70 Foot, the *Counterpoise* of the Weight that goes into the Pump, is to hang upon as many Pulleys as may serve to make it rise and fall within the Space by which the Height of the Pump exceeds the Height of the Water. And because by this Means the *Counterpoise* will rise and fall slower, and consequently by less Proportions than the Weight it self, the first Pulley may have upon it a Wheel or two, to turn *Indexes* at any Proportions required, so as to give the minute Parts of the Motion, and Degrees of Risings and Fallings. And because if the Hole, by which the Water is let into the Pump be as large as the Bore of the Pump itself, the Weight that is raised by the Water, will rise and fall with an Undulation according to the Inequality of the Seas Surface: 'Twill therefore be fit, that the Hole, by which the Water enters, be less than half as big as the Bore of the Pump; any Inconvenience that may fall thereupon, as to the Periods and Stations of the Flood and Ebb, not being considerable.

5. To observe the Position and Strength of the Wind, the State of the Weather; The Heights of the Barometer, Thermometer, Hygroscope, and the Moon's Age and Place in all Respects.

IV. 1. The true Time of the Tides at all Times of the Moon, is very rudely and slightly reckoned up by most Seamen and Astronomers, most of them reckoning, as if the Moon being upon such a set Point of the Compass (as the Seaman calls it) or so many Hours past the Meridian (as the Almanack-makers reckon) it were High-Tide in such and such a Port at all Times of the Moon. And thus they reckon the Tides every Day to differ constantly 48 Minutes. As for Instance, a South-west Moon makes a full Tide at London, that must be understood that it is high Tide at London, when the Moon is 3 Hours past the Meridian. Now this is true indeed at the new and full Moon, but not at other Times of the Moon, which few take any Notice of: Only Mr. Booker had wont to give this Caveat, that about the first and last Quarters of the Moon, the Neap Tides did not flow so long as the Spring-Tides by one Point of the Compass; but he gives no Rule to proportion the Difference.

Tides observed at London, by Mr. Hen. Philips, n. 34. p. 656.

But

But observing this more narrowly, I find, that at *London* the Tides fall out at the least *Two Points*, that is, an Hour and a half sooner, in the *Quarters* than in the *new* and *full Moon*. I have also found by many Trials, that the true Time of the Tides might be found out to be somewhat shorter and shorter, from the *new* and *full Moon* unto the *Quarters*, yet not in an equal manner, neither gradually decreasing from the *new* and *full Moon* until the *Quarters*; but rather, that there was some little Difference of Alteration both at the *new* and *full Moons*, and also at the *Quarters*, and that the greatest Difference fell out in the midst between them, agreeing very well to a *circular Proportion* after this Manner.

Fig. 50.

1. Divide a Circle into 12 equal Parts or Hours, according to the Moon's Motion, or Distance from the Sun from the *new Moon* to the *full*.
2. Let the *Diameter* of the Circle be divided into 90 Parts or Min. That is, according to the Time of the Difference of Tides between the *new* or *full Moon*, and the *Quarters*, which is one Hour and an half.
3. Make perpendicular Lines cross the *Diameter* of the Circle from Hour to Hour.
4. Reckon the Time of the Moon's coming to the South in the Circumference of the Circle, and observe the perpendicular Line that falls from that Point upon the *Diameter*; and the proportional Min. cut thereby, will shew how many Hours or Min. are to be subtracted from the Time of high Tides at the *new* and *full Moon*, that so you may have the true Time of the Tides that present Day.

For Example, At *London*, on the Day of *new* and *full Moon*, it is high Tide at 3 of the Clock, that is, when the Moon is 3 Hours past the Meridian, and so by the common Rule, the Moon being about 4 Days old, it will be S. about 3 of the Clock, and it will be high Tide 3 Hours afterwards, that is, at 6 of the Clock. But now by this Rule, if you count this Time of the Moon's coming to the South in the Circumference, the perpendicular Line which comes from 3 to 9, cuts the *Diameter* at 45 Min. which shews, that so much is to be abated from the Time of high Tide in the *new* and *full Moons*; so that it is high Tide 45 Min. before 6 of the Clock; that is, at 5 Hours 45 Min. and not at 6 of the Clock, according to the common Rule.

The like you may do for any other *Port* or *Place*, knowing the Time of *high Water* at the *new* and *full Moon* in that Place: And you may do it the more readily, if you set down the Time of *high Water* at the *new* and *full Moon* under the *Diameter*, as I have done for *London*, where it is high Tide at 3 of the Clock: So that when the Moon is South at 3 of the Clock, the Perpendicular cuts the *Diameter* at 2 Hours 15 M. and so when the Moon is South at 9 of the Clock, by adding Two Hours 15 Min. you may have the Time of *High Water*, which is 11 of the Clock and 5 Min.

And thus you may easily make a Table, which by the southing of the Moon shall readily tell you the Time of high Tide at any Time of the Moon, as I have done here for *London*: To which all other Places may be reduced to correspond.

Moon

Moon South.		Tide London.		Moon South.		Tide London.		Moon South.		Tide London.		Moon South.		Tide London.	
H.	M.	H.	M.	H.	M.	H.	M.	H.	M.	H.	M.	H.	M.	H.	M.
XII.	03	0		III.	05	15		VI.	07	30		IX.	011	15	
	103	9			105	21			107	4			1011	29	
	203	18			205	27			207	52			2011	43	
	303	27			305	33			308	7			3011	57	
	403	36			405	40			408	1			4012	10	
	503	40			505	46			508	25			5012	24	
I.	03	54		IV.	05	52		VII.	08	36		X.	010	37	
	104	2			105	59			108	48			1012	50	
	204	9			205	6			209	0			201	3	
	304	16			306	13			309	13			301	16	
	404	23			406	20			409	26			401	29	
	504	30			506	28			509	35			501	42	
II.	04	37		V.	06	36		VIII.	09	53		XI.	01	54	
	104	44			106	44			1010	6			102	3	
	204	50			206	53			2010	20			202	16	
	304	57			307				3010	32			302	27	
	405	3			407				4010	47			402	38	
	505	9			507	20			5011	01			502	49	

These Things I have found to fall out right at *London* for many Years, and so I suppose they may in other Places; if the Difference be not so much between the *Neap-tides* and *Spring-tides* in other Places, the Diameter must be divided into fewer Parts.

2. Having taken Notice that the Tides seldom hold out so long as Mr. *Philips's* Calculation gives them, I observed them my self more diligently, and with the Help of my Friends and Servants, I noted the Times of above 80 high Waters at *Tower-wharf* and *Greenwich*, whereby I found that the greatest and least Differences betwixt the Moon's true Southing and the high Waters, were not, as Mr. *Philips* had placed them, at the full or new and Quarter Moons, but the greatest nearer to the *Neaps*, the least to the highest *Spring-tides*. I found also, that the Inequality was not the same that he had made it, and after a Tryal or two, that I could represent and answer above 60 of these Observations with less than one Quarter of an Hour's Difference; which considering how difficult it is to determine the time of an high-Water exactly, I cannot but esteem a very good Agreement.

3. At the Bar of *Dublin*, on the new and full Moons, a S. S. E. Moon makes high Water, that is, at half an Hour past Ten.

At *Rings-end*, at 3 Quarters after 10.

At the *Custom-house* at *Dublin*, at 11.

By Mr. Flamstead, n. 143 p. 12.

At Dublin, by Mr. W. Molineux, n. 184 p. 192.

On.

On the Quarter Days.

High-water on the Bar, at 5 a Clock.

At Rings-end, at a Quarter past 5.

At the Custom-house, half an Hour past 5.

A *Southerly Wind* between S. S. E. and S. S. W. blowing fresh, makes it flow near half an Hour longer than its usual Course.

N. B. That this Observation makes the Tides, upon the *Quarter-Moons*, come in later, in respect of the *Moon's Southing*, than upon *new* and *full Moons* by half an Hour; whereas in the River of *Thames*, as high as *London*, the *Quarter-Moons* make *high Water* above an Hour and Quarter sooner, in that Respect, than the *new* and *full*; as may be seen in the accurate Tide-Tables of Mr. *Flamsteed*; but it is from hence evident, that the same Tables are not applicable to the *Sea-ports*, where there is not the same Reason for the Anticipation of the *Neap-Tides* upon the *Quarter-Moons*.

The Cause of this *Phenomenon* seems to be, that the *Impulse* of the Ocean in the *Quarter-Moons* is not so vigorous as in the *new* and *full*, nor the Motion of the Waters so quick, (as is evident by daily Experience :) Whence it comes to pass, that in the open Sea, and in Ports upon the Sea-Coast, as this of *Dublin*, the *High-water Time* falls out later than when the Motion is more rapid in the *new* and *full*; but on the contrary, in Rivers, at any considerable Distance from the Sea, the Resistance of the Weight of the fresh Water, which is kept suspended during the Time of the Flood, is longer overcome by the more potent *Impetus* in the *new* and *full*, than by the weaker in the *Quadratures*; and from hence this Difference should be still more and more considerable, as the Port is farther remov'd from the Sea.

Nigh Pli-
mouth, by
Mr. Sam.
Colepreſt, n.
33. p. 632.

4. Our *diurnal Tides* from about the latter End of *March*, till the latter End of *September*, are about a Foot higher (perpendicular, which is always to be understood) in the Evening than in the Morning, that is, in every Tide that happens after 12 in the Day, before 12 at Night. On the contrary, the Morning Tides from *Michaelmas* till our *Lady-Day* in *March* again, are constantly higher by about a Foot, than those that happen in the Evening. And this Proportion holds in both after the gradual Increase of the Tides Rising from the *Neap* to the highest *Spring*; and the like Decrease of its Height till *Neap* again is deducted.

The highest *menſtrual Spring Tide* is always the *Third Tide* after the *new* or *full Moon*, if a cross Wind do not keep the Water out, as the *N. E.* or *N. W.* usually doth; whose contrary Wind, if strong, commonly makes those to be high Tides upon our Southern Coasts which otherwise would be but low.

The highest *Springs* make the lowest *Ebbs*, (Tho' I am informed by an expert *Water-man*, that it sometimes happens, that there may be a very low *Ebb*, tho' no high Spring, which they term an *Out-let*, or *Gorges* of the Sea; as when a great Storm chances off at Sea, and not on the Land.)

The Water neither flows nor ebbs alike in respect of equal Degrees; but its *Velocity* increaseth with the Tide till just at *Mid-water*, that is, *half flown*, or at half Flood, at which Time the *Velocity* is strongest, and so decreaseth

pro-

proportionably 'till high Water, or full Sea. As may be guessed at by the following Scheme collected by Observations made at several Times and Places. And although it be restrain'd to *Plymouth Haven*, or the like, where the Water riseth about 16 Foot (I say usually, because it may vary in this Port from the lowest Neap to the highest Annual Spring above 7 or 8 Foot) yet it may indifferently serve for other Places, where it may rise as many Fathom, or not so high, by a proportional Addition or Substraction.

	Time.	Height.
	<i>b</i>	' f. inch.
Flowing	1	0 1 6
	2	0 2 6
	3	0 4 0
	4	0 4 0
	5	0 2 6
	6	0 1 6

	Time.	Height.
	<i>b</i>	' f. inch.
Ebbing	1	0 1 6
	2	0 2 6
	3	0 4 0
	4	0 4 0
	5	0 2 6
	6	0 1 6

The usual Number of Tides, or Times of high Water from new Moon to new Moon, or from full Moon to full Moon, is 59.

5. 1. I have observed, that our Annual Spring Tides do happen in *March* and *September*, either at the Tide next before the Sun's Ingress into the æquinoctial Points of *Aries* and *Libra*, or the next Tide after, according as the Moon is near her Full or Change, when the Sun thus enters into the said Signs: And then it flows in Height about 45 Foot; the lowest Neap Tides flowing in Height 25 Foot.

2. That the lowest Neap makes the highest Spring, if the *N. E.* Winds hinder not, by blowing hard, and so keep back the Tides; as usually they do when they blow: Whose contrary Winds, *S. W.* if they blow hard, make here the highest Tides.

3. That from about the latter End of *September*, they are about 1 Foot and 3 Inches higher, perpendicularly, in the Evening than in the Morning; that is, if high Water happen after the Sun is past the *Meridian* or in the Tides betwixt Noon and Mid-night. But from *Michaelmas* to our *Lady-Day*, we find the contrary, the Day-Tides being, in that Season, higher by 15 Inches than the Night-Tides, or the Tides between Mid-night and Noon. And this Proportion holds in both, after the gradual Increase of the Tides rising from the Neap to the highest Spring, and the like Decrease of their Height till Neap again.

4. That the highest menstrual Spring-Tide is always the Third after the full Moon or Change-Day, if it be not kept back by *N. E.* Winds.

5. That it flows here on the Change-Day, when the Moon is *E. S. E.* the Tide flowing in for the Space of 5 Hours, and Ebbing 7 Hours. But in Neap Tides it does not flow here by two Points of the Compass so long.

Vol. II.

M m

6. That

In Hong-
road, 4 Miles
from Bristol;
By Cap. Sam.
Sturmy, n.
14. p. 813.

Signs.

6. That the Water flows nor ebbs equal Spaces in equal Times, but its Velocity is strongest at the first, both of the Flood and Ebb, and so gradually decreaseth until full Sea, or low Water. This is observed in Spring Tides only, as you may see by the following Table, which I have made for my Observations of our Tides here. And I have farther observed, that it hath flow'd or ebb'd at the first of the Tide one Foot in 6 Minutes, or that then the Tide ran out a Foot in 6 Minutes, or did rise so much in Height.

	Time.	Height.
	<i>h</i>	<i>f. inch</i>
	0	15 2 7 $\frac{1}{2}$
	0	30 2 6
	0	45 2 6
	1	00 2 6
	0	15 2 6
	0	30 2 5 $\frac{1}{2}$
	0	45 2 5
	2	00 2 5
Flowing	0	15 2 3
	0	30 2 3
	0	45 2 3
	3	00 2 3
	0	15 2 2
	0	30 2 1
	0	45 2 1
	4	00 2 1
	0	15 1 9
	0	30 1 8
	0	45 1 8
	5	00 1 8
	5	0 44 1

	Time.	Height.
	<i>h</i>	<i>f. inch.</i>
	0	15 2 7 $\frac{1}{2}$
	0	30 2 6
	0	45 2 6
	1	00 2 6
Ebbing.	2	00 9 0
	3	00 8 0
	4	00 6 9
	5	30 5 0
	6	00 4 0
	7	00 3 0
	7	00 44 10 $\frac{1}{4}$

7. The usual Number of Tides from new Moon to new Moon, or from Full to Full, is 59.

8. In the River of *Severn*, 20 Miles above *Bristol* near *Newnham*, 160 Miles from the River's Mouth (*Lundy*) the Head of the Flood at its coming in in Spring Tides, ariseth in Height like a Wall 9 Foot high, and so runs for many Miles together, covering at once all the Shoals which were dry before; at which time all *Vessels*, that lye in the Way of the said head Tides, or (as it is vulgarly call'd) *Boar*, are commonly overfet, or carried upon the Banks, and the Head of the Tide being past, such *Vessels* are left dry again. It flows there but two Hours and 18 Foot in Height, and it ebbs ten Hours. The Reason of the said *Boar* is doubtless the straitning and shoaling of the River

in that Place, it being there but half a Mile broad ; as it is but 20 Peaches over, three Miles higher ; running tapering to Gloucester.

6. We have been informed by a curious Gentleman, that the *Annual highest* At Chepstow, by ... ib. p. 816. *Tides* about Chepstow Bridge, were at St. David's and Michaelmas Stream ; that is, the one a little before the *Vernal*, and the other somewhat after the *Autumnal Equinox* which agrees also with the Conjecture of a very intelligent *Mathematician*, who is withal of Opinion, that because both are not far from the *Equinoxes*, tho' the one before, the other after, it might well give occasion to think it was depending on the *Equinox*.

7. Our great Bay Mr. Camden calls *Wasbes*, whereas they are only two small Arms of the Sea, running into it, viz. *Fosdike* and *Cross-Keys* ; 'tis full of Sands, making two Channels to *Lynn*, and as many to *Boston*. It may be useful to Travellers to have a Table when to pass over the said *Wasbes*, tho' without a Guide, I would not advise them, especially after great Freshes, which make the Sands shift, and consequently quick, and Horses many times stick fast : The Way to get them out is, by several Peoples trampling round them at a Distance, which by Degrees raiseth them.

A Table of the Walhes in Lincolnshire, by Mr. Chr. Merritt n. 223.p.352.n. 224.p. 392.

<i>Moon's Age.</i>	<i>Fosdike begins.</i>	<i>Ends.</i>	<i>Full Sea.</i>	<i>Moon's Age.</i>	<i>Fosdike begins.</i>	<i>Ends.</i>	<i>Full Sea.</i>
	<i>b.</i>	<i>'b.</i>	<i>'b.</i>				
1	16 10	04	45 7	09	24 4	24 11	09 1
2	17 10	48 5	33 7	48 10	25 5	12 11	57 2
3	18 11	36 6	21 8	36 11	26 6	01 2	45 3
4	19 12	24 7	9 9	24 12	27 6	48 1	33 3
5	20 1	12 7	57 10	12 13	28 7	36 2	21 4
6	21 2	08	45 11	01 4	29 9	24 3	9 5
7	22 2	48 9	33 11	48 15	30 9	12 3	57 6
8	23 3	36 13	21 12	36			

Cross-Keys, begins to be fordable fifteen Minutes after *Fosdike*, and ends an Hour sooner.

8. It is high Water upon the Day of the *new* and *full Moon*.

On the Coast of *Gascony* and *Guienne*.

At 3 *b.* At the Mouth of *Garonne*, and the Isle of *Rhee*.

At 3 $\frac{1}{2}$ at St. *John de Luz*, at *Bayonne*, and *Memissan*.

At 3 $\frac{1}{4}$ *b.* at *Roban*, *Brouage*, and *Rochelle*.

At 3 *b.* On the Coast of *Poitou*.

At 3 $\frac{3}{4}$ *b.* at *Ollonne* and *Beauvoir*.

On the Coast of *Britany*.

At 1 $\frac{1}{2}$ *b.* at *Bell-Isle*.

At 3 *b.* at the Mouth of the *Loyre*, at *Garande*, *Morbihan*, *Blavet*, and *Concarneau*.

M m z

At

The Tides in France, by ... n. 185. p. 220.

At $\frac{1}{4}$ h. at *Apenars, Vannes, and Auray.*

At $2\frac{1}{4}$ h. at *Apenmark, Audierne, the Race of Fontenay, and Le Conquet.*

At $2\frac{1}{2}$ h. at *Brest, and at Cape de Four.*

At 4 h. at *St. Paul de Leon.*

At $4\frac{1}{2}$ h. at *Port Blanc.*

At 6 h. at *St. Malo and Cancale.*

On the Coast of Normandy.

At 7 h. at *Granville, and Barneville.*

At 8 h. at *Cherbourg and Barfluer.*

At 9 h. at *Caen and Honfleur, at the Mouth of the Seine, and at Havre de Grace.*

At $9\frac{1}{2}$ h. at *Fescan, and St. Valeri.*

At $10\frac{1}{2}$ h. at *Rouen, Dieppe, and Treport.*

On the Coast of Picardie.

At 11 h. at the Mouth of the *Somme, at Estaple, Bologne, and Ambletense.*

At 11 h. at *Calais.*

At 12 h. at *Dunkirk, Newport and Ostend.*

*At Bermu-
das, by Mr.
Rich. Nor-
wood, n. 30.
p. 565.*

9. I. I have only taken a general notice of the *Tides*, as that it is high Water about 7 of the Clock on the *Change-Day* (in some *Creeks* an Hour or two later.) The *Water* riseth but little, as about 4 Foot at *high Water*, but at *Spring-Tides* it may be a Foot more. The *Tides* without are very various in *Setting*: Sometimes the Tide of Flood sets to the Eastward, sometimes to the Westward, but in fair, calm, and settled Weather, the said Tide sets from the South-East toward the North-West, as they say.

*By Mr. Rich.
Stafford, n.
40. p. 792.*

2. The Water about our Island (*Bermudas*) does not flow, by any Man's observation, above 5 Foot; and that but at one Season of the Year, between *Michaelmas* and *Christmas*; at other Times not above 3 Foot. It is high Water when the Moon is about an Hour high, and the like after her going down. It flows in from the *North-West*, and runs to the *South East* nearest; and in that Part of the Land, which lies most to the *North-West*, there it is high Water soonest. But the Tide does not always ebb and flow directly that Course round about our Coast; but I suppose, the Reason is, that some Points of Land, or Shoals may turn its North-West and South-East Course.

*At Cabo
Cora Castle on
the Coast of
Guinea, by
Mr. Heath-
cot, n. 158.
p. 578.
Antihypothe-
sis about the
Flux and Re-
flux of Seaby
Dr. Wallace,
n. 16. p. 235.*

10. The Sea runs here along the Shore continually to the *Eastward*, at a very great Rate except at Full and Change, for then it runs to Westward, or at least makes a great Abate. Nov. 24th, 1683. I took the Time of the high Water at the *Castle* (as near as I could) at 3 h. 30. p. m. it flowed about 6 Foot.

V. I. The *Sea's ebbing and flowing* hath so great a Connection with the Moon's Motion, that in a Manner all *Philosophers* (whatever other Causes they have

have joined with it) have attributed much of its Cause to the *Moon*; which either by some *occult Quality*, or particular Influence which it hath on moist Bodies, or by some *magnetick Virtue*, drawing the Water towards it, (which should therefore make the Water there highest, where the *Moon* is vertical) or by its Gravity and Pressure downwards upon the *terraqueous Globe* (which should make it lowest where the *Moon* is vertical) or by whatever other Means (according to the several Conjectures of inquisitive Persons) hath so great an Influence on, or at least a Connection with the *Sea's Flux and Reflux*, that it would seem very unreasonable to seclude the Consideration of the *Moon's Motion* from that of the *Sea*: The *Periods of Tides* (to say nothing of the Greatness of them near the *new Moon*, and *full Moon*) so constantly waiting on the *Moon's Motion*, that it may be well presumed, that either the one is governed by the other, or at least both from some common Cause.

The first that I know of, who took in the Consideration of the *Earth's Motion*, (*Diurnal and Annual*) was *Galileo*: Who in his *System of the World*, hath a particular and very rational Discourse on this Subject. But that Discourse is to be look'd upon only as an Essay of the general Hypothesis; which as to Particulars, was to be afterwards adjusted from a good *general History of Tides*; which 'tis manifest enough that he had not; and which is yet in a great Measure wanting.

And what I say of *Galileo*, I must in like Manner desire to be understood of what I am now ready to say to you. For I do not profess to be so well skill'd in the *History of Tides*, as that I will undertake presently to accommodate my general Hypothesis to the particular Cases; or that I will indeed undertake for the certainty of it, but only as an Essay propose it to farther Consideration, to stand or fall, as it shall be found to answer Matter of Fact.

I consider therefore that in the *Tides*, or the *Flux and Reflux* of the *Sea*, besides extraordinary Extravagancies, or Irregularities, whence great Inundations, or strangely high Tides do follow, which yet perhaps may prove not to be so merely accidental as they have been thought to be, but might from the regular Laws of Motion, if well consider'd, be both well accounted for, and even foretold; there are these three notorious Observations made of the *Reciprocation of Tides*. First the *Diurnal Reciprocation*, whereby twice in somewhat more than 24 Hours, we have a Flood and an Ebb; or a high Water and low Water. Secondly, the *Mensrual*; whereby in one *synodical Period* of the *Moon*, suppose from *full Moon* to *full Moon*, the Time of those *diurnal Vicissitudes* doth move round thro' the whole Compass of the *Νυχθημερον*, or natural Day of 24 Hours: As for instance, if at the *full Moon*, the *full Sea* be at such or such a Place just at Noon, it shall be the next Day, at the same Place, somewhat before one of the Clock; the Day following, between one and two; and so onward, till at the *new Moon* it shall be at Mid-night; (the other Tide, which in the *full Moon* was at *Mid-night*, now in the *new Moon* coming to be at Noon) and so forward, till at the next *full Moon* the *full Sea* shall at the same Place come to be at Noon again. Again, that of the *Spring Tides* and *Neap Tides*, as they are call'd, about the *full Moon* and *new Moon* the Tides are at the highest, at the *Quadratures* the Tides are at the

the lowest: And at the Times intermediate proportionably. *Thirdly*, the *Annual*; whereby it is observed, that at some times of the Year the *Spring Tides* are yet much higher, than the *Spring Tides* at other times of the Year: Which times are usually taken to be at the *Spring* and *Autumn*, or the two *Æquinoxes*; but I have Reason to believe, (as well from my own Observations for many Years, as of others, who have been much concerned to heed it, whereof more will be said by and by,) that we should rather assign the beginning of *February* and *November*, than the two *Æquinoxes*.

1. Now in order to give an Account of these three Periods, according to the Laws of Motion and Mechanick Principles; we shall first take it for granted what is now a-Days pretty commonly entertained by those who treat of such Matters; that a Body in *Motion* is apt to continue in its *Motion*, and that in the same Degrees of *Celerity*, unless hinder'd by some contrary *Impediment*: Like as a Body at rest to continue so, unless by some sufficient Mover, put into Motion: And accordingly, which daily Experience testifies, if on a Board or Table, some loose incumbent Weight be for some Time *moved*, and have thereby contracted an *Impetus* to *Motion* at such a *Rate*, if that Board or Table chance by some external Obstacle, or otherwise, to be stopped, or considerably retarded in its Motion, the incumbent loose Body will shoot forward upon it; and contrariwise, in Case that Board or Table chance to be accelerated or put forward with a considerably greater Speed than before, the loose incumbent Body not having yet obtained an equal *Impetus* with it, will be left behind, or seem to fly backward upon it. Or, which is *Galileo's* Instance, if a broad Vessel of Water, for some time evenly carried forward with Water in it, chance to meet with a Stop, or to slack its Motion, the Water will dash forward and rise higher at the fore part of the Vessel; and contrariwise, if the Vessel be suddenly put forward faster than before, the Water will dash backwards, and rise at the hinder part of the Vessel. So that an *Acceleration* or *Retardation* of the Vessel which carries it, will cause a rising of the Water in one Part, and a falling in another; which yet by its own Weight, will again be reduced to a Level as before. And consequently, supposing the *Sea* to be but as a loose Body carried about with the Earth, but not so united to it as necessarily to receive the same Degree of *Impetus* with it, as its fixed Parts do. The *Acceleration* or *Retardation* in the Motion of this or that Part of the Earth, will cause, more or less, according to the Proportion of it, such a *dashing* of the Water, or *rising* at one Part, with a *falling* at another, as is that which we call the Flux and Reflux of the Sea.

Now this premised, we are next, with him, to suppose the Earth carried about with a double Motion, the one *Animal* in *BEC*, the great Orb, in which the Center of the Earth *B*, is supposed to move about the Sun *A*. The other Diurnal, whereby the whole moves upon its own *Axis*, and each in its Surface describes a Circle, as *DEFG*.

It is then manifest, that if we suppose that the *Earth* moved but by any one of these *Motions*, and that regularly with an equal *Swiftness*, the *Water* having once attained an equal *Impetus* thereunto, would still hold equal Pace with it, there being no occasion, from the quickning or slackning of the *Earth's* Motion, in that Part where the *Water* lieth, for the *Water* thereon either to be

cast

cast forward or backward, and thereby to *accumulate* on the other Parts of the *Water*: But the true Motion of each Part of the Earth's Surface being compounded of those two *Motions*, the *Annual* and *Diurnal*; (the *Annual* in *BEC*, being, as *Galileo* there supposeth, about three Times as fast as a *diurnal Motion* in a great Circle, as *DEF*;) while a Point in the *Earth's* Surface moves about its Center *B*, from *G* to *D* and *E*, and at the same Time its Center *B* be carried forwards to *C*; the true *Motion* of that Point forwards, is made up of both those *Motions*; to wit, of *B* to *C*, and of *G* to *E*; but while *G* moves by *D* to *E*, *E* moves backward by *F* to *G*, contrary to the Motion of *B* to *C*; so that the true Motion of *E*, is but the Difference of *BC*, and *EG*: (For, besides the Motion of *B*, above the Center, *G* is also put forward as much as from *G* to *E*, and *E* put backward as much as from *E* to *G*;) So that the *Diurnal Motion*, in that Part of the *Earth*, which is next the *Sun*, as *EFG*, doth abate the Progress of the *Annual*, and most of all at *F*; and in the other Part, which is from the *Sun*, as *GDE*, it doth increase it, and most of all at *D*; that is, in the *Day* Time there is abated, in the *Night* Time is added, to the *Annual Motion*, about as much as is *GE*, the *Earth's* Diameter. Which would afford us a Cause of two *Tides* in 24 *Hours*; the one upon the greatest *Acceleration* of *Motion*, the other upon its greatest *Retardation*.

2. And thus far *Galileo's* Discourse holds well enough; but then in this it comes short; that as it gives an Account of *two Tides*, so those *two Tides* are always to be at *F*, and *D*; that is, at *Noon* and at *Midnight*: Whereas Experience tells us, that the time of *Tides* moves in a Month's Space through all the 24 *Hours*; of which he gives us no Account. For though he do take notice of a *menstrual Period*; yet he doth it only as to the Quantity of the *Tides*, greater or less; not as to the Time of the *Tide*, sooner or later.

To help this *J. Bapt. Balianus* makes the *Earth* to be but a *secondary Planet*, and to move not directly about the *Sun*, but about the *Moon*, the *Moon* mean while moving about the *Sun*, in like Manner as we suppose the *Earth* to move about the *Sun*, and the *Moon* about it. But though this might furnish us with the Foundation of a *menstrual Period* of *Accelerations* and *Retardations* in the compound Motion of several Parts of the *Earth's* Surface, yet there is no good Reasons to admit of this *Hypothesis*.

Instead of this, that *Surmise* of mine, (for I dare not yet, with Confidence, give it any better Name) of what I have spoken to you heretofore, (and which hath occasioned this present Account which I am now giving you) is to this Purpose.

The *Earth* and *Moon* being known to be Bodies of so great Connection, as that the *Motion* of One follows that of the Other, may well enough be looked upon as one Body, or rather one aggregate of Bodies, which have one common Center of Gravity, which Center of Gravity, according to the known Laws of *Statics*, is in a strait Line connecting their respective Centers, so divided, as that its Parts be in reciprocal Proportion to the Gravities of the two Bodies. As for Example, suppose the *Magnitude* (and therefore, probably, the Gravity) of the *Moon* to be about a *one and fortieth* Part of that of the *Earth*: And the Distance of the *Moon's* Center from the Center of

Riccioli.
Alm. Nov.
Tom. 1. l. 4.
c. 10. n. 111.
p. 216. 2.

of the *Earth*, to be about 56 *Semidiameters* of the *Earth*, the Distance of the common Center of Gravity of the two Bodies, will be from that of the *Earth* about $\frac{1}{57}$ of 56 *Semidiameters*, that is about $\frac{1}{57}$ of a *Semidiameter* of the *Earth*, above its Surface, in the Air, directly between the *Earth* and *Moon*.

Now supposing the *Earth* and *Moon*, jointly as one Body carried about by the *Sun*, in the great Orb of the *Annual* Motion; this Motion is to be estimated, (according to the Laws of *Statics* in other Cases) by the Motion of the common Center of Gravity of both Bodies. For we use in *Statics* to estimate a Body, or aggregate of Bodies, to be moved upwards, downwards or otherwise, so much as its common Center of Gravity is so moved, howsoever the Parts may change Places amongst themselves.

And accordingly the Line of the *Annual* Motion will be described, not by the Center of the *Earth* (as we commonly estimate it) but by the common Center of Gravity of the Bodies, *Earth* and *Moon*, as one aggregate.

Fig. 52. Now supposing *ABCDE*, to be a Part of the great Orb of *Annual* Motion, described by the common Center of Gravity, in so long Time as from a full *Moon* at *A*, to the next new *Moon* at *E*; the Center of the *Earth* at *T*, and that of the *Moon* at *L*, must each of them, (supposing their common Center of Gravity to keep the Line *AE*) be supposed to describe a Periphery about that common Center, as the *Moon* describes her Line of *menstrual* Motion. And in like Manner, *EFGHI*, from the new *Moon* at *E*, to the next full *Moon* at *I*.

Fig. 53 From *A* to *E*, (from full Moon to new Moon) *T* moves (in its own *Epicycle*) upwards from the *Sun*: And from *E* to *I*, (from new Moon to full Moon) it moves downwards, towards the *Sun*. Again, from *C* to *G*, (from last Quarter to the following first Quarter) it moves forward according to the *Annual* Motion; but from *G* forwards to *C*, (from the first Quarter to the ensuing last Quarter) it moves contrary to the *Annual* Motion.

It is manifest therefore, according to this *Hypothesis*, that from the last Quarter to the first Quarter (from *C* to *G*, while *T* is above the Line of the *Annual* Motion) its *menstrual* Motion in its *Epicycle* adds somewhat of *Acceleration* to the *Annual* Motion; and most of all at *E*, the new Moon: And from the first to the last Quarter (from *G* forward to *C*, while *T* is below the Line of the *Annual* Motion) it abates of the *Annual* Motion; and most of all at *I*, or *A* the full Moon.

So that in Pursuance of *Galileo's* Notion, the *menstrual* adding to, or deducting from the *Annual* Motion, should either leave behind, or cast forward the loose Waters incumbent on the *Earth*, and thereby cause a *Tide*, (or Accumulation of Waters) and most of all at the full Moon and new Moon, where those *Accelerations* or *Retardations* are greatest.

Now this *menstrual* Motion, if nothing else were superadded to the *Annual*, would give us two *Tides* in a Month, and no more; (the one upon the *Acceleration*, and the other on the *Retardation*) at new Moon and full Moon; and two Ebbs at the two Quarters; and in the Intervals, rising and falling Water.

But the *Diurnal* Motion, superadded, doth the same to this *Menstrual*, which *Galileo* supposeth it to do to the *Annual*; that is, doth add to, or subtract from

from the *menstrual Acceleration or Retardation*; and so gives us *Tide upon Tide*.

For in whatsoever part of its *Epicycle* we suppose *T* to be; yet because, *Fig. 54.* while by its *menstrual Motion*, the Center moves in the Circle *LTN*; each Point in its Surface, by its diurnal Motion, moves in the Circle *LMN*: Whatever Effect (accelerative or retardative) the *Menstrual* would give, that Effect, by the Diurnal, is encreased in the Parts *LMN*, (or rather *LMn*, the Semicircle) and most of all at *M*; but diminished in the Parts *NOL* (or rather *nOl*) and most of all at *O*. So that *M* and *O*, (that is, when the Moon is in the *Meridian* below or above the *Horizon*) we are to have the *diurnal Tide* or *high Water*, occasion'd by the greatest *Acceleration or Retardation*, which the *Diurnal Arch* gives to that of the *Menstrual*; which seems to be the true Cause of the *daily Tides*, and withal gives an Account, not only why it should be every Day, but likewise why at such a Time of the Day; and why this time should in a Month run through the whole 24 Hours, *viz.* because the Moon's coming to the *Meridian* above and below the *Horizon*, (or as the Seamen call it, the Moon's *Southing* and *Northing*) doth so: and likewise of the *Spring-tides* and *Neap-tides*. For, when it so happens, that the *menstrual* and *diurnal Accelerations or Retardations*, be coincident, (as at the new Moons and full Moons they are) the Effect must needs be the greater. And although (which is not to be dissembled) this happen but to One of the Two *Tides*; that is, the *Night-tide* at the new Moon (when both Motions do most of all *accelerate*, and the *Day-tide* at full Moon (when both do most retard the *annual Motion*;) yet, this *Tide* being thus raised by two concurrent Causes; tho' the next *Tide* have not the same Cause also, the *Impetus* contracted will have Influence upon the next *Tide*; upon a like Reason, as a *Pendulum* let fall from a higher *Arch*, will (tho' there be no new Cause to occasion it) make the Vibration on the other Side (beyond the Perpendicular) to be also greater: Or, of Water in a broad Vessel, if it be so jogged, as to be cast forward to a good height above its Level, will upon its Recoiling, by its own Gravity, (without any additional Cause) mount so much the higher on the hinder Part.

But here also, we are to take notice, that though all Parts of the Earth, by its *diurnal Motion*, do turn about its Axis, and describe parallel Circles, yet not equal Circles; but greater near the *Æquinoctial*, and lesser near the Poles; which may be a Cause why the *Tides* in some Parts may be much greater than in others. But this belongs to the particular Considerations, (of which we are not now giving an Account) not to the general *Hypothesis*.

3. The *annual high Tides* having been observed (grossly) to happen about the *Spring* and *Autumn*, they are generally referred to the two *Æquinoxes*. But the Inhabitants of *Rumney-marsh* in *Kent*, where the Sea being kept out with great Earthen Walls, that it doth not at *high Water* overflow the Level; are generally agreed by their Observations, (and Experience dearly bought) that their Times of Danger are about the Beginning of *February* and of *November*: That is, at those *Spring-tides* which happen near those Times; to which they give the Names of *Candlemas Stream*, and *Allballond Stream*: And if they escape those *Spring-tides*, they apprehend themselves

out of Danger for the rest of the Year. And as for *March* and *September* (the two *Æquinoxes*) they are as little solicitous of them, as of any other Part of the Year. And I have my self very frequently observed (both at *London*, and elsewhere) that in those Months of *February* and *November*, (especially *November*) the Tides have run much higher than at other times; particularly in *November* 1660. I found the Water so high in *King-street Westminster*, that it came up not only into the Boots, but into the Body of the Coach; and the *Palace-yard* (all save a little Place near the West-end) overflowed; as likewise the Market-place; and many other Places; and their Cellars generally filled up with Water. And in *November* 1665, it may be well remembred what very high Tides there were, not only on the Coasts of *England* (where much Hurt was done by it) but much more in *Holland*, where, by reason of those Inundations, many Villages and Towns were overflowed.

'Tis true, there does not happen any single signal Accident, which might cast it on these times, yet there is a Compound of Two that may do it: Which is the *Inequality* of the natural Day, (well known to *Astronomers*) arising from a double Cause. First, because the Sun, by reason of its *Apo-gæum* and *Perigæum* doth not at all Times of the Year dispatch, in one Day, an equal Arch of the *Ecliptick*: Secondly, Equal Arches of the *Ecliptick* do not in all Parts of the *Zodiack* answer to equal Arches of the *Æquinoctial*, by which we are to estimate Time.

According to the first of these Causes, we should have the longest Natural Days in *December*, and the shortest in *June*, which if it did operate alone, would give us at those Times two annual high Waters. According to the second Cause, if operating singly, we should have the longest Days in the two *Solstices* in *June* and *December*, and the two shortest at the *Æquinoxes*, in *March* and *September*; which would at those Times give Occasion of four annual high Waters.

But the true Inequality of the natural Days, arising from a Complication of those two Causes; sometimes crossing, and sometimes promoting each other, though we should find some Increases or Decreases of the natural Days, at all those Seasons answerable to the respective Causes, (and perhaps of Tides, proportionably thereunto: Yet the longest and shortest natural Days absolutely of the whole Year (arising from this Complication of Causes) are about those times of *Allhallontide* and *Candlemas*; (or not far from them) about which those annual high Tides are found to be: As will appear by the *Tables of Equation of natural Days*. And therefore, I think, we may with very good Reason, cast this annual Period upon that Cause, or rather Complication of Causes. For (as we before shewed in the *menstrual* and *diurnal*) there will, by this Inequality of natural Days, arise a physical *Acceleration* and *Retardation* of the *Earth's* mean Motion, and accordingly a casting of the Waters backward or forward; either of which will cause an Accumulation or high Water.

I must here add, (that I be not mistaken) that whereas I cast the Time of the daily Tides to be at all Places, when the Moon is there in the Meridian;

it must be understood of *open Seas*, where the Water hath such free Scope for its Motion, as if the whole Globe of Earth were equally covered with Water: Well knowing, that in *Bays* and *inland Channels*, the Position of the Banks and other like Causes must needs make the Times to be much different from what we suppose in the *open Seas*: And likewise, that even in the *open Seas*, *Islands*, and *Currents*, *Gulfs* and *Shallows* may have some Influence, though not comparable to that of the *Bays*, and *Channels*. And moreover, though I think that Seamen do commonly reckon the time of *high Water* in the open Seas, to be then, when the Moon is there in the Meridian (as this *Hypothesis* would cast it:) Yet I do not take my self to be so well furnished with a History of *Tides*, as to assure my self of it; much less to accommodate it to particular Places and Cases.

It may be thought perhaps, that if the Earth would thus describe an *Epicyle* about the common Center of Gravity, it would (by this its Change of Place) disturb the celestial Motions, and make the apparent Places of the Planets, especially some of them, different from what they would otherwise be. For though so small a Removal of the Earth, as the *Epicyle* would cause, (especially if its Semi-diameter should not be above $1\frac{1}{2}$ of the Earth's Semi-diameter) would scarce be sensible, if at all, to the remoter Planets; yet as to the nearer it might.

To this my Answer is, that such Difference hath been observ'd, and hath very much puzzl'd *Astronomers* to give an Account of. Mr. *Horrocks* was fain to have Recourse to somewhat like *Kepler's amicable Fibres* (which he had no Affection to at all) to give Account of the Inequalities of the Moon's Motion. And other *Astronomers* have introduced (some upon one Supposition, some upon another) some kind of *menstrual Equation*, to solve the Inequalities of the Moon's Motion, according to her *Synodical Revolution*, or different Aspects (of new Moon, full Moon, &c.) besides what concerns her one periodical Motion. For which, this Consideration of the common Center of Gravity of the Earth and Moon, is so proper a Remedy (especially if it should be found precisely to answer those *Phænomena*, which I have not examined, but am very apt to believe) that it is so far from being, with me, an Objection against it, that it is one of the Reasons, which make me inclinable to introduce it.

The like Consideration may reasonably be had of *Jupiter* and *Saturn*, and their *Satellites*, which yet, because of their Smallness, may chance to be so little, as that at this Distance, the Change of their apparent Places may not be discernable. For all these *Satellites* are to their Principals, as so many Moons to the Earth. And Mr. *Horrocks* expresseth some such little Inequalities in *Saturn's* Motion, of which he could not imagine what Account to give: Which, for aught I know, might have been accounted for, if at that Time the *Satellites* of *Saturn* had been discovered, and that Mr. *Horrocks* had thought of such a Notion as the common Center of Gravity of *Saturn* and his Companions, to be considerable, as to the guiding of his Motion.

2. 1. To the first Objection, *That it appears not how two Bodies, that have no Tye, can have no common Center of Gravity*: That is (for so I understand the Intendment of the Objection) can act or be acted in the same manner, as if

Some Objections answered; By Dr. Wallis. ib. p. 281.

if they were connected; I shall only answer, that it is harder to shew how they have, than that they have. That the Loadstone and Iron have somewhat equivalent to a Tye, though we see it not, yet by the Effects we know. And it would be easy to shew, that two Loadstones, at once applied, in different Positions, to the same Needle, at some convenient Distance, will draw it not to point directly to either of them, but to some Point between both; which Point is, as to those two, the common Center of *Attraction*; and it is the same as if some one Loadstone were in that Point. Yet have these two Loadstones no Connexion or Tye, though a common Center of Virtue, according to which they jointly act. And that there is somewhat that doth connect the Earth and Moon, (as much, as what connects the Loadstone, and the Iron which it draws,) is past doubt to those, who allow them to be carried about by the Sun, as one Aggregate or Body, whose Parts keep a respective Position to one another: Like as *Jupiter* with his four *Satellites*, and *Saturn* with his one.

To the Second Objection; *That at Chatham and in the Thames, the annual Spring-tides happen about the Equinoxes; not (as this Hypothesis doth suppose elsewhere to have been observed) about the Beginning of February and November.* If their Meaning be, that *annual high Tides* do then happen, and then only, if this prove true, it will ease me of half my Work: For it is then easily answered, that it depends upon the *Obliquity* of the *Zodiack*, the Parts of the *Equinoctial* answering to equal Parts of the *Zodiack*, being near the *Solstitial* Points greatest, and near the *Equinoctial* Points least of all. But besides, this *annual* Vicissitude of the *Equinoxes*, not to say of the *Four Cardinal Points* (which my *Hypothesis* doth allow and assert) I believe it will be found, that there is another *annual* Vicissitude answering to the *Sun's Apogæum* and *Perigæum*. And that the greatest Tides of all will be found to be upon a Result of these two Causes co-operating. And to what is said to be observed at *Chatham*, and in the *Thames*, contrary to that I alledge, as is observ'd in *Rumney-marsh*; I must at present ἀπέχεσθαι, and refer to a *melius inquirendum*. For a good Diary of the Height and Time both of high Water, and low Water, for a Year or two together, even at *Chatham*, or *Greenwich*; but rather at some Place in the open Sea, or at the *Land's End* in *Cornwal*, or on the West Parts of *Ireland*; or at *St. Helen's* or the *Bermudas*, &c. would do more to the resolving of this Point, than any verbal Discourse without it.

3. To the third Objection, *That supposing the Earth and Moon to move about a common Center of Gravity; if that the highest Tides be at the new Moon when the Moon being nearest to the Sun, the Earth is farthest from it, and its Compound Motion at the swiftest; and that the Tides abate as the Earth approacheth nearer, till it comes into the supposed Circle of her annual Motion: It may be demanded, why do they not still abate, as the Earth comes yet nearer to the Sun, and the Swiftness of its compound Motion still slackens? And so, why have we not Spring-tides at the new Moon (when the Motion is swiftest) and Neap-tides at full Moon (when the Motion is slowest:)* But *Spring-tides* at both? The Answer, if observed, is already given in my *Hypothesis* it self. Because

Because the Effect is indifferently to follow, either upon a sudden *Acceleration*, or a sudden *Retardation*. Now both of these happening, the one at the new Moon, the other at the full Moon, do cause high Tides at both.

4. To the 4th Objection, *That the highest Tides are not at all Places, about the new Moon, and full Moon; and particularly, that in some Places of the East-Indies, the highest Tides are at the Quadratures*: I answer in general; That as to the particular *Varieties of Tides* in several Parts of the World, I cannot pretend to give a satisfactory Account, for Want of a competent History of *Tides*, &c. Because, as is intimated in what I wrote in the general, the various Positions of *Channels, Bays, Promontories, Gulphs, Shallows, Currents, Trade-winds*, &c. must needs make an innumerable Variety of Accidents in particular Places, of which no satisfactory Account is to be given from the general *Hypothesis*, though never so true, without a due Consideration of all those. Which is a Task too great for me to undertake, being so ill furnished with Materials for it.

5. To the 5th Objection, *That the Spring-tides happen not with us just at the Full and Change, but Two or Three Days after*: I should with the more Confidence attempt an Answer, were I certain, whether it be so in the open Seas, or only in our *Channels*. For the Answers will not be the same in both Cases. If only in our *Channels*, where the *Tides* find a large Indraught, but not in the open Seas, we must then seek a Reason of it from the particular Position of these Places: But if it be so generally in the wide open Seas, we must then seek a Reason of it from the general *Hypothesis*: And, till I know the Matter of Fact, I know not well which to offer at. I know that Mariners use to speak of *Spring-tides* at the New and Full of the Moon; though I have still had a Suspicion, that it might be some Days after, as well in the open Seas, as in our narrower *Channels*. And therefore I have chosen to say, in my Papers, about the New and the Full, rather than at the New and Full; and even when I do say At, I intend it in that laxer Sense, in which I suppose the Mariners are to be understood, for Near that Time. The Truth is, the Flux and Reflux of Water in a Vessel by reason of the jogging of it, though it follow thereupon, yet is, for the most Part, discernable some time after. For there must, upon that Jog, be some time for Motion, before the Accumulation can have made a *Tide*. And so I do not know but that we must allow it in all the Periods: But in my conjectural *Hypothesis*, while it is yet but a Candidate, I did not think my self obliged to speak more nicely.

But now, after all, the clearest Evidence for this *Hypothesis*, if it can be had, will be from *Celestial* Observations. As for Instance; supposing the *Fig. 55.*
Sun at *S*, the *Earth's* Place in its annual Orb, at *T*; and *Mars* (in Opposition to the Sun or near it) at *M*: From whence *Mars* should appear in the Zodiac at γ , and will at full Moon be seen there to be, the Moon being at *C*, and the *Earth* at *C*; and the like at the new Moon. But if the Moon be in the First Quarter at *A*, and the *Earth* at *a*; *Mars* will be seen, not at γ , but at *a*; too slow: And when the Moon is at *B*, and the *Earth* at *b*, *Mars* will

will be seen at β ; yet too slow: Till at the full Moon, the Moon at C , the Earth at c , Mars will be seen at γ , its true Place, as if the Earth were at T . But then after the Full, the Moon at D , the Earth at d ; Mars will be seen, not at γ , but at δ ; too forward, and yet more when the Moon, at the last Quarter, is at E , the Earth at e , and Mars seen at ϵ . If therefore Mars, when in *Opposition* to the Sun, be found, all other Allowance being made, somewhat too backward before the full Moon, and somewhat too forward after the full Moon, and most of all, at the Quadratures, it will be the best Confirmation of the *Hypothesis*. The like may be fitted to Mars in other Positions, *mutatis mutandis*, and so for the other Planets.

But this Proof is of like Nature as that of the Parallax of the Earth's annual Orb to prove the Copernican Hypothesis. If it can be observed, it proves the Affirmative, but if it cannot be observed, it proves the Negative, but only proves that the Semi-diameter of the Earth's Epicycle is so small as not to make any discernable Parallax. And indeed I doubt that will be the Issue. For the Semidiameter of this Epicycle, being little more than the Semi-diameter of the Earth itself, or about $\frac{1}{4}$ thereof, as is conjectured, in the Hypothesis from the Magnitudes and Distances of the Earth and Moon compared; and there having not as yet been observed any discernable Parallax of Mars, even in his nearest Position to the Earth, it is very suspicious, that here it may prove so too.

The Variety
of the Annual
Tides, in se-
veral Places
of England,
consider'd, by
Dr. Wallis,
n. 34. p. 652.

3. In my Hypothesis for Tides, I cast the annual high Tides for the Coast of Kent, and consequently the Rivers of Thames and Medway, about the Beginning of November and February. Which agrees with Observations on those Coasts, and particularly with that of yours [Mr. Oldenburgh's] of Feb. 5. 1667.

The last Year [1667] when I was present in the R. S. I remember an Account was brought us of the annual high Tides on the Severn, and at Cheap-flow-bridge, to be about the Beginning of March, and the End of September. Which though they agree not with the particular Times on the Coast of Kent, yet in the general they agree thus far, That the one is about as much before the one *Equinox*, as the other is after the other *Equinox*. You now acquaint me with the high Tides about February 22, about the Coast of Plymouth, which is later than that of the Coast of Kent, but sooner than that on the Severn. And I doubt not but that in other Parts of the World will be found other Varieties.

The Reasons of these Varieties are, as I have formerly signified, to be attributed to the particular Position of those Parts rather than to the general Hypothesis.

Of which this, in brief, may serve for some Account at present. The General Hypothesis of the Earth's diurnal Motion from West to East, would cast that of the Waters, not following so fast from East to West, which causeth the constant Current within the Tropicks, where the Circles are greatest, Westward from the Coast of Africa to that of America, which is also the Cause of the constant Eastern Breeze blowing in those Parts. But the Sea thus beating on the Coast of America, is cast back as with an Eddy on either Hand, and consequently

quently returns from the *American Shore* Eastward towards the Coast of *Europe*, where the parallel Circles to the *Æquator* being less, and consequently the *diurnal Motion* slower, doth not cast the Water so strongly Westwards, as between the *Tropicks*, and so not strong enough to overcome the *Eddy*, which it meets with from the other Motion, which gives the Sea a North-easterly Motion on these Coasts, as to its usual Course. The *Current* therefore of our Seas being North-easterly, we are next to consider, at what time it runs more to the North, and at what more to the East. When it runs most Northerly, it runs up the *Irish-Sea*, and so up the *Severn*: When most Easterly, it runs straight up the *Channel*, and so to the Coast of *Kent*: When between these it beats against *Devonshire* and *Cornwall*, and those Parts. We are therefore to consider, as to the annual Periods, that the annual Motion of the Earth in the *Zodiack*, and the *diurnal* in the *Æquator*, are not precisely in the same Direction, but make an *Angle* of $23\frac{1}{2}$ *Deg.* at the *Æquinoxes*, but run, as it were, parallel at the *Solstices*; and as they be nearer or farther from these Points, so is the Inclination varied, which several Directions of Motion do cause the compound Motion of both to vary from the East and West more or less, according as the Sun's Position is farther or nearer the *Solstices*; and therefore nearer to the *Æquinoxes*. This *Inclination* doth cast the constant *Current* of our Seas more to the North and South, and farther from it more to the East and West; which is the Reason, why the *Current* up the *Irish-Sea* is nearer to the *Æquinoxes* (at the Beginning of *March*, and End of *Sept.*) and up the *Channel* or narrow Seas, farther from it, (at the Beginning of *Febr.* and of *Nov.*) and against the Coasts of *Devonshire* and thereabouts, at some intermediate Time.

4. I fear Dr. Wallis may be mistaken about the annual Vicissitudes of the Tides, which he contendeth to be about *Allhallantide* and *Candlemas*; For, Animadversions upon Dr. Wallis's Hypothesis; by Mr. Jos. Childrey, n. 64. p. 2061.
 1. Our *English Seamen* (who are more to be trusted than the Inhabitants of *Rumney-marsh*) use to say, that the highest Tides in the Year seem to happen rather about the *Æquinoxes*, than those two other assigned Times, when the natural Days are longest and shortest.

2. If that which he supposeth should be the Cause of the *high Tides*, he mentions at *London* in *Nov.* 1660, and 1665, the like might be expected every *November*; and as frequently in *February*; of which he gives not one Instance. But those high Tides in the *Thames* in *November*, if we dare credit the *London Watermen*, are caused by the coming down of the *Land-waters*, after a very great Rain, which being encounter'd by the Tide of Flood from the Mouth of the *Thames*, cannot but swell to an unusual Height. To induce us to believe which, we need only consider, that the latter End of *Octob.* and the Beginning of *Nov.* (or rather both those whole Months) are generally the rainiest Part of the whole Year. Now if the great Rains fall so that the *Land-waters* come down to the flowing Part of the *Thames* just upon the Full or Change, when the Spring-tides happen, as they did (for Example) *Sept.* 30. 1555. and *Octob.* 22. 1629, (*Stow* and *Howes* are my Authors) those Spring-tides must be the higher, as proceeding from a double Cause.

3. There

3. There is another thing notoriously known by all Seamen to be a Cause of *high* or *low Tides*, namely, the sitting of the Wind at such or such a Point of Compass, and blowing hard. It is the constant Saying of all Seamen in *Kent*, that ever I met with, that the North-west Winds make the *highest Tides* in the *Thames*, *Medway*, and all the Coasts about the *South* and *North-forelands*; and likewise on the Coast of *Holland* and *Flanders*. And the Reason they alledge for it is, because, say they, that Wind doth with equal Force blow in the Tide of Flood on both Ends of this Island of *Britain*; that is, from the Northward between the Coasts of *Scotland*, *Norway*, and *Jutland*; and also from the Westward by the Coasts of *Cornwal*, *Devonshire*, *Dorsetshire*, &c. up along the *Sleeve*; and for the same Reason, they say, (and I think truly) that a South-east Wind deads and hinders the Tides there. Agreeably to this I very well remember, when I was a Boy and lived at *Rocheſter*, that when the Tides were unuſually high, the Wind was always *N. W.* and the Moon near the Full or Change. And the Inhabitants about *Chatham*, the Hundred of *Hoo*, and the Isle of *Graine*, will with one Voice ſay, that they never fear their low *Marſhes* being overflowed by the Tide, but when the Wind is at *N. W.* or thereabouts, upon the *Spring-tides*. Here at *Weymouth*, thoſe able and antient Seamen I have talked with, tell me, that a *S. S. E.* Wind makes the greateſt Tides, and that according to the Degree of the Wind, *ceteris paribus*, the Tides riſe more or leſs notably, but that they never obſerve any extraordinary ſwelling Tides about *Allballontide* or *Candlemas*, unleſs the Wind be about *S. S. E.* And the Reason they give for that Wind's raiſing the Tides there, is, in my Opinion, very convincing, if we conſider the lying of the Haven in the Map. And for the ſame Reason, I ſuppoſe, the Wind from the ſame Point may make the *highest Tides* at *Southampton*; a Weſterly Wind at *Bristol* and *Severne*; an Eaſterly Wind at *Hull*; a North-eaſt Wind at *Wifbych* and *Lynn*; a Southerly Wind upon the oppoſite Coaſts of *England*, and *Ireland*, &c. And I am confident if more particular Enquiry be made in *Rumney-marſh*, it will be found, that *Dimchurch Wall* is never in Danger of being overflowed or broken by the Tides, but upon very ſtormy and tempeſtuous Weather; eſpecially when the Wind either blows right upon the Shore, or when it ſits in that Point that raiſeth the Tides high-eſt there. And if we do but conſider that *Allballontide* and *Candlemas* are no more famous for the longeſt and ſhorteſt natural Days, than they are generally infamous for ſtormy Weather; eſpecially the former Seaſon, (*Wet* and *Windy* Weather being moſt concomitant) we have good Ground to attribute *high Tides* at thoſe times of the Year to another Cause than the Author ſuppoſeth, and make a more than probable Conjecture at the Occaſion of the Miſtake. It is true, *March* is very often more ſtormy than *February*, (tho' ſeldom ſo ſtormy as *October* and *November*) which poſſibly might occaſion that Opinion, which ſome hold, (of which Number *Pliny* is one) that the high-eſt Tides are about the *Æquinoxes*. And if the Thing were found to hit pretty frequently in *March*, Men might not be careful to obſerve the other *Æquinox*, tho' yet it cannot be deny'd, that we have bluſtering Weather many times before *Michaelmas*. In Confirmation of all this that I have ſaid, concerning the Influence of the

the Winds being considerable on the Tides, I shall add these following Collections of my own out of Histories, Chronicles, &c.

1250. *Octob. 1.* (Saith *Holinshead*) upon the *Change* of the *Moon*, was a most dreadful Inundation of the Sea, that did exceeding much hurt to *Holland* beyond Sea, *Holland* in *Lincolnshire*, and the *Marsh Ground* in *Flanders*, and drowned *Winchelsea*. But he tells us withal, that an unheard of Tempest of Wind accompanied it.

1555. *Sept. 30.* (Saith *Stow*) was a notable Inundation of the *Thames*, but he saith withal, that it was by occasion of a great Wind and Rain that had fallen; the Moon was in *Perigæo*.

1572. *March 10.* I find this Manuscript Note in Latin in an Ephemerides for that Year, over against the Day; *Septentrionis maxima Sævitia: Nivis flocci magni, ingens, frigus. Maxime tumescebat æstus Maris die & nocte, nam ex-currebat in Agros late.*

1592. *Sept. 6. Wednesday,* (saith *Stow*) the Wind being West and by South, as it had been for 2 Days before very boisterous, the *Thames* was made so void of Water, by forcing out the fresh, and keeping back the salt, that Men in diverse Places might go 200 Paces over, and then fling a Stone to Land, &c.

1600 *Decemb. 8.* I find this Note written in another Ephemerides for that Year, over against the Day, by an unknown Person, who, as it seems, was then at *Venice*, (where a South East Wind makes the highest Tides) *Inundatio venit 6 ped. temp. Sirocco.*

1601. (Saith *Grimston* in his *Netherland History*) the Sea being forced in by a strong *N. W.* Wind, did some Mischief to *Ostend*.

1601. *Octob. 26. St. n.* a great Tempest, saith the same Author, and the Wind *W. N. W.* and the Tide much higher than usual at *Ostend*.

1602. *Feb. 23, 24. St. n.* Blew a terrible North West Wind, which made the Water rise higher than usual at *Ostend. Idem.*

1604 *March 1. n. st.* The Wind was very great at *West* and *North West*, with a furious Tempest, the Tide at *Ostend* rising so high, as it had not done in Forty Years before. *Idem.*

The *Perigæosis* of the Moon also seems to have, at least, some Influence on the *Tides*, and to make them swell higher than else they would do. For I have found by observing the *Tides*, as often as I had leisure, several high *Tides* and *Inundations*, tho' I must not say all, to happen upon the Moon's being in, or very near her *Perigæum*. For Example.

That famous Inundation mentioned before out of *Holinshead*, 1250, *Oct. 1.* was when the Moon was in *Perigæo*, as appears by Calculation.

1530. *Nov. 5.* That Inundation on which was made the Distick.

*Anno ter deno post sequimille, Novembris
Quinta, stat salis Zelandia tota sub Undis.*

Was, when the Moon was in Perigæo.

Jan. 13. 1557. The Sea, saith *Michell* in his Chronicle, brake in at *Sandwich*, and overflowed all the *Marshes* thereabout, and drowned much Cattle, the Moon in Perigæo.

1570. Nov. 1. Was a dreadful Flood at *Antwerp*, and on all the Coasts of *Holland*, that made infinite Spoil; the Moon in Perigæo.

1600. Dec. 8. Above mentioned; the Moon in Perigæo.

1609, Jan. 20. Was a great Inundation in *Severne*, mentioned in *Hov's* Chronicle; that did much Hurt in *Somersetshire* and *Gloucestershire*, &c. the Moon in Perigæo.

1643. Jan. 23. *ft. n.* saith a little *Low-Dutch* Chronicle that I have, was a terrible High-water Flood in *Friesland*, &c. whereby much Hurt was done to the *Dykes*; and at *Gaes* by *Haerlingen*, the dead Bodies streamed out of the *Earth*; the Moon in Perigæo.

1651. Feb. 23. *ft. n.* (saith the same Chronicle) was *St. Peter's* high Flood, whereby much Hurt was done to the *Dykes* in *Friesland*, *Emderland*, and elsewhere; and not far from *Dockum*, by *Oudt-woudumer Zilt*, is a Breach of 42 Roods long, broken in the Dyke. the Moon in Perigæo.

Aug. 2. 1657. *ft. v.* At *Feversham*, where I then lived, was a very high Spring-tide; and yet the Wind was at South East, which deads the Tides there; the Moon in Perigæo.

Aug. 22. 1658. *ft. v.* At *Faversham* was a very high Tide in the Afternoon, tho' the Wind was Southerly, and blew very stiff, which the Seamen there wondred at; the Moon in Perigæo.

1661. Upon *Michaelmas* Day was a great Overflowing of the *Severne*, that it drowned the lower Ground lying by it; I lived then in *Gloucestershire*, and immediately as soon as I heard of it, I noted it down in my *Memorandum*; the Moon in Perigæo.

The Scheme of the *Weather* printed in the *History of the R. S.* tells us, that May 24, 1663, was a very great Tide at *London*. But it tells us withal that the same Day the Moon was in Perigæo.

Sept. 19. 1669. Here at *Weymouth*, I observed my self a very high Tide; and so did several Seamen in that Town, who wondred at it, the Weather being very calm, and that little Wind that was, being at North-East, which uses to contribute nothing at all to the Tides in that Haven; the Moon in Perigæo.

Farther, that which inclines me to believe that the Perigæosis of the Moon is of some Concernment in this Matter, is, because it is a *Maxim* amongst our *Kentish* Seamen, that they never have two running Spring-tides (as they call them) together, but that the next Spring-tide, after a high running Spring, is proportionably weak and slack; which, if true, is very correspondent to my Opinion; because if the Moon be in Perigæo at this Spring-tide, she shall be in Apogæo at the next. Accordingly I have received this Account at *Weymouth*, that this present Feb. 1672, the Spring-tides ran very high after the Change, though the Weather was pretty calm, and that Wind that was not very favourable

vourable to the Tides, and that the Spring-tides after the Full, were very low and weak, which is exactly according to my Conjecture.

But I conceive that the best *Touch-stone* to prove the Soundness of my Opinion (which I confess I never had the Opportunity to do yet) is to have it observ'd, whether those Neap-tides be not apparently higher, *consideratis considerandis*, that happen at the Moon's being in *Perigæo* either at the first or last Quarter: Because it is a received and demonstrable Truth in *Astronomy*, that the Moon being in *Perigæo* at either Quarter, comes then nearer the Earth, than when it is in *Perigæo* at the Change or Full.

5. That the *Winds* have a great Influence on the Tides of particular Coasts and Havens, I do not at all question; and the like I say of *Land-waters* which are, as to inland Rivers, very considerable; especially as to Inundations upon rising of the Water: For that the Tide and Land Flood should jointly make a greater Inundation than either singly would have done, is not to be doubted. but in my Essay I take no Notice of these, because my Business was to give a statical Account of stated Periods, *Diurnal, Menstrual, Annual*, arising from regular Motions, not of accidental Extravagancies, such as these are.

The Moon's *Perigæosis* also is far from being contrary to my *Hypothesis*: But for as much as it doth not still fall out at the same Time of the *Day, Month, or Year*, I could not make it a component of any of those noted Periods *Diurnal, Menstrual, or Annual*; and of more Periods than these, I did not know that there hath been any general Notice taken, of which I might think myself obliged to give an Account: But it may very well influence any or all those, according as it falls out advantageous or disadvantageous for them.

And as I do so readily concur with him in all the Particulars by him suggested; so I think he will not be difficult in assenting to all the Materials of my *Hypothesis*. The Account which I give of the *Diurnal* and *Menstrual* Periods, from the common Center of the Gravity of the Earth and Moon, he doth allow as very rational, and consequently, which is the Foundation of it, that any *Acceleration* or *Retardation* of the compound Motion of the particular Parts in the Earth's Surface, is to give such an *Accumulation* of Waters as causeth a Tide; and the Complication of such *Accelerations* and *Retardations* concurring or interfering one with another, doth occasion the perplex Varieties in them.

If therefore there be no other Periods of Tides but these, or no other remarkable, my Work is done, and I need not be farther solicitous: For then there will seem to be either no other Inequality of *Motions*, or none considerable. But, if there be also observable an *Annual* Period, (as perhaps there may be) then are we to seek for the Cause thereof in somewhat of Inequality, which doth (for the *Annual* Period, annually recur; or for any other Period) which doth recur in such a time as that other Period doth require.

'Tis true, I have not insisted on the Moon's Apogæum, and Perigæum, with the Inequality of *Motion* depending on it; or the *Obliquity* of its *Orb*, which causeth another Inequality both in the Motion of *Longitude* and *right Ascension*, because I did not know of any periodical Vicissitude of Tides consonant thereunto.

thereunto. When any such shall be discovered, we have here a Foundation ready for the salving of it. And I the rather think they may be considerable, because the *Earth* and *Moon's* *Appropinquation* and *Elongation*, doth really alter the Distance of the common Center of Gravity, of the *Earth* and *Moon*, from the *Earth*, rendring the *Earth's* Epicycle elliptical; and much favours what Mr. *Childrey* observes of the *Moon* in *Perigæo*. But as to any annual Vicissitude, it is not of Use, because it doth not annually recur.

But if the annual *high Tides* be at the *Æquinoxes*, not at the times I have assign'd, then so much of the *Hypothesis* as concerns the *Excentricity* may be spared, (or allowed to be so little as not to be remarkable) and that of the *Obliquity* alone will give a sufficient Account of it. Or if (to which he seems rather to incline) there be no such annual Vicissitudes at all; then may that of the *Obliquity* be spared also, and yet the *Hypothesis* be perfect without it. And till some such be observed and acknowledged, it will be sufficient to say, That tho' both the *Excentricity* and *Obliquity* do cause some Inequality in the Motion, yet so little, as that in the *Tides* it is not remarkable, they falling just as if the three Motions, (Annual, Menstrual, Diurnal,) were all exactly circular, and on parallel Axes.

But as to Matter of Fact in *Rumney-marsh*, I say, that according to the best Account I can there get, and the unanimous Consent as well of Fishermen, and other Watermen, as of other Inhabitants, it is constant, hardly missing (or very seldom) any one Year, be the Weather fair or foul: And as well about *Candlemas*, as about all *Allballontide*, every Year, tho' not then so high: Of which, tho' they do not pretend to give any Reason of it, I think a Cause may be very rationally assigned. For if you consult the Tables of the *Inequality of natural Days*, which Parallel I make use of for the Explication of this, you will find, that about one of the Extrems, in *Jan.* the Increase and Decrease of the natural Days fluctuates very much, sometimes increasing, sometimes decreasing, according as this or that of the two Causes, thwarting one another, doth prevail: But about the other Extream, in *October*, it is much otherwise; the Increasing and Decreasing going on in a continual Course for a long Time together. And the same Causes applied to the Business of *Tides*, may very rationally be supposed to produce as unequal Effects. And tho' the Seamen at *Weymouth* have not observ'd any such signal Effects about *Allballontide* and *Candlemas*, yet those about *Chepstow* observe the like to happen about the Beginning of *Mar.* and End of *Sept.* the one as much before the Vernal, as the other is after the Autumnal *Æquinox*, like as in our Case it happens, which they call by the Name of *St. David's Stream*, and *Michaelmas Stream*; as we do those in *Kent*, *Candlemas Stream*, and *Allballon Stream*. Of these different Seasons at *Chepstow Bridge*, from those of *Rumney-marsh*, I have already given my Remarks. But since it is not yet (it seems) agreed, Whether such an Annual *Phænomenon* happen; or, if so, not at that time; so that for aught yet appears, it may be at the Seasons I design, that is, between the *Winter Solstice*, and the two *Æquinoxes* on either side of it, though, on several Coasts severally remote, I think it best to let this Part of the *Hypothesis* stand as it is unrevoked, as that which when it shall be

be discovered, and agreed on, stands ready enough to give a rational Account of it, and, in the mean Time, does no hurt. And in such a Complication of Causes so abstruse, scarce any thing but Observation will determine, which of the Causes, and in what degree, is to be judged predominate.

VI. The sole Principle upon which Mr. *Newton* proceeds to explain most of the great and surprising Appearances of Nature, is no other than that of Gravity, whereby in the Earth all Bodies have a Tendency towards its Center; and there is the like Gravitation towards the Center of the Sun, Moon, and all the Planets.

Mr. Newton's Theory
of the Tides
Explained by
Mr. Halley.
n. 226. p. 445.

Now this Force of Descent decreases, as the Square of the Distance of the heavy Body from the Center increases.

There is also Room to suspect, that the Force of Gravity is, in the *celestial Globes* proportional to the Quantity of Matter in each of them.

From these Principles it is evident, that if the *Earth* were alone, that is to say, not affected by the Actions of the Sun and Moon, the Ocean being equally pressed by the Force of Gravity, towards the Center, would continue in a perfect *Stagnation*, always at the same Height, without either *ebbing* or *flowing*; but the Sun and Moon having a like Principle of Gravitation towards their Centers, and the *Earth* being within the Activity of their Attractions, it will plainly follow, that the Equality of the Pressure of Gravity towards the Center, will thereby be disturbed; and though the Smallness of these Forces, in Respect of the Gravitation towards the *Earth's* Center, renders them altogether imperceptible by any Experiments we can devise, yet the Ocean being Fluid and yielding to the least Force, by its rising shews where it is less press'd, and where it is most press'd by its *sinking*.

P. 445.

Now if we suppose the Force of the *Moon's* Attraction to decrease, as the Square of the Distance from its Center increases (as in the *Earth* and other *celestial Bodies*) we shall find, that where the Moon is perpendicularly either above or below the *Horizon*, either in *Zenith* or *Nadir*, there the Force of Gravity is most of all diminished, and consequently that there the Ocean must necessarily swell by the coming in of the Water from those Parts where the Pressure is greatest, viz. in those Places where the Moon is near the *Horizon*. Thus let *M* be the Moon, *E* the Earth, *C* its Center, and *Z* the Place where the Moon is in the *Zenith*, *N* where in the *Nadir*. Then by the Hypothesis it is evident, that the Water in *Z*, being nearer, is more drawn by the Moon, than the Center of the Earth *C*, and that again more than the Water in *N*, wherefore the Water in *Z*, has a Tendency towards the Moon, contrary to that of Gravity, being equal to the Excess of the Gravitation in *Z*, above that in *C*: And in the other Case, the Water in *N*, tending less towards the Moon than the Center *C*, will be less pressed, by as much as is the Difference of the Gravitations towards the Moon in *C* and *N*. Thus rightly understood, it follows plainly, that the *Sea*, which otherwise would be *Spherical*, upon the Pressure of the Moon, must form it self into a *spheroidal* or *oval* Figure, whose longest Diameter is where the Moon is Vertical, and shortest where she is in the *Horizon*; and that the Moon shifting her Position as she turns round the Earth once a Day, this *Oval* of Water.

Fig. 50.

Water shifts with her, occasioning thereby the two Floods and Ebbs observable in each 25 Hours.

And this may suffice, as to the general Cause of the *Tides*; it remains now to shew how naturally this Motion accounts for all the Particulars that has been observ'd about them; so that there can be no Room left to doubt, but that this is the true Cause thereof.

The *Spring-tides* upon the new and full Moons, and *Neap-tides* on the Quarters, are occasioned by the attractive Force of the Sun in the New and Full conspiring with the Attraction of the Moon, and producing a *Tide* by their united Forces: Whereas in the Quarters, the Sun raises the Water where the Moon depresses it, and the contrary; so as the *Tides* are made only by the Difference of their Attractions. That the Force of the Sun is no greater in this Case, proceeds from the very small Proportion the Semidiameter of the Earth bears to the vast Distance of the Sun.

It is also observ'd, that *ceteris paribus*, the *Æquinoctial Spring-tides* in *March* and *Sept.* or near them, are the highest, and the *Neap-tides* the lowest; which proceeds from the greater Agitation of the Waters, when the fluid *Spheroid* revolves about a great Circle of the *Earth*, than when it turns about in a lesser Circle; it being plain, that if the Moon were constituted in the *Pole* and there stood, that the *Spheroid* would have a fixt Position, and that it would be always High-water under the *Poles*, and Low-water every where under the *Æquinoctial*: And therefore the nearer the Moon approaches the *Poles*, the less is the Agitation of the Ocean, which is of all the greatest, when the Moon is in the *Æquinoctial*, or farthest distant from the *Poles*. Whence the Sun and Moon being either conjoined or opposite in the *Æquinoctial*, produces the greatest *Spring-tides*; and the subsequent *Neap-tides*, being produced by the Tropical Moon in the Quarters, are always the least *Tides*; whereas in *June* and *Decem.* the *Spring-tides* are made by the Tropical Sun and Moon, and therefore less vigorous, and the *Neap-tides* by the *Æquinoctial* Moon, which therefore are the stronger. Hence it happens, that the Difference between the *Spring* and *Neap-tides* in these Months is much less considerable, than in *March* and *September*. And the Reason why the very highest *Spring-tides* are found to be rather before the *Vernal* and after the *Autumnal Æquinox*, viz. in *Feb.* and *Oct.* than precisely upon them, is, because the Sun is nearer the *Earth* in the Winter Months, and so comes to have a greater Effect in producing the *Tides*.

Hitherto we have considered such Affections of the *Tides* as are universal, without Relation to particular Cases; what follows from the differing Latitudes of Places, will be easily understood by the following Figure.

Fig. 57.

Let *A p E P*, be the *Earth*, cover'd over with very deep Waters; *C*, its Center; *P p* its *Poles*; *A E* the *Æquinoctial*; *F f* the *Parallel of Latitude* of a Place; *D d* another *Parallel* at equal Distance on the other Side of the *Æquinoctial*; *H b* the two Points where the Moon is vertical; and let *K k* be the great Circle wherein the Moon appears *Horizontal*. It is evident, that a *Spheroid* described upon *H b*, and *K k* shall nearly represent the Figure of the *Sea*, and *C f*, *C D*, *C F* *C d*, shall be the *Heights of the Sea* in the Places, *f*, *D*, *F*, *d*, *F*.

D, F, d , in all which it is High-water : And seeing that in 12 Hours time, by the diurnal Rotation of the Earth, the Point F , is transferred to f , and d , to D : The Height of the Sea $C F$, will be that of the High-water when the Moon is present ; and $C f$, that of the other High-water, when the Moon is under the Earth : Which in the Case of this Figure is less than the former $C F$.

And in the opposite Parallel $D d$, the contrary happens. The rising of the Water being always alternately greater and less in each Place, when it is produced by the Moon declining sensibly from the *Æquinoctial*; that being the greatest of the two High-waters in each diurnal Revolution of the Moon, wherein she approaches nearest either to the *Zenith* or *Nadir* of the Place : Whence it is, that the Moon in the *Northern* Signs, in this Part of the World, makes the greatest *Tides* when above the Earth, and in the *Southern* Signs, when under the Earth ; the Effect being always the greatest where the Moon is farthest from the *Horizon*, either above or below it. And this alternate Increase and Decrease of the *Tides* has been observ'd to hold true on the Coast of *England*, at *Bristol* by Capt. *Sturmy*, and at *Plymouth* by Mr. *Colepreff*.

But the Motions hitherto mentioned are somewhat altered by the Libration of the Water, whereby though the Action of the *Luminaries* should cease, the *Flux* and *Reflux* of the Sea would for some time continue. This Conservation of the impressed Motion diminishes the Differences that otherwise would be between two consequent *Tides*, and is the Reason why the highest *Spring-tides* are not precisely on the new and full Moons, nor the *Neaps* on the Quarters ; but generally they are the *Third Tides*, after them, and sometimes later.

All these things would regularly come to pass, if the whole Earth were covered with Sea very deep : But by Reason of the Shoalness of some Places, and the Narrowness of the *Streights*, by which the *Tides* are in many Cases propagated, there arises a great Diversity in the Effect, and not to be accounted for, without an exact Knowledge of all the Circumstances of the Places, as of the Position of the Land, and the Breadth and Depth of the Channels by which the *Tide* flows ; for a very slow and imperceptible Motion of the whole Body of the Water, where it is, for Example, 2 Miles deep, will suffice to raise its Surface 10 or 12 Feet in a *Tide's* Time ; whereas, if the same Quantity of Water were to be conveyed upon a Channel of 40 Fathoms deep, it would require a very great Stream to effect it, in so large Inlets as are the *Channel* of *England* and the *German Ocean* ; whence the *Tide* is found to set strongest in those Places where the Sea grows narrowest, the same Quantity of Water being to pass through a smaller Passage : This is most evident in the *Streights*, between *Portland* and *Cape de Hague* in *Normandy*, where the *Tide* runs like a *Sluce*, and would be yet more between *Dover* and *Calais*, if the *Tide* coming about the Island from the North did not check it. And this Force being once impressed upon the Water, continues to carry it above the Level of the ordinary Height in the *Ocean*, particularly where the Water meets a direct Obstacle, as it is at *St. Malo's* ;

St. Malo's; and where it enters into a long Channel, which running far into the Land, grows very strait at its Extremity, as it is in the *Severn Sea* at *Chepstow* and *Bristol*.

This Shoalness of the Sea, and the intercurrent Continents are the Reason, that in the open Ocean the time of High Water is not at the Moon's Ap-pulse to the Meridian, but always some Hours after it; as it is observed upon all the *West Coast* of *Europe* and *Africa*, from *Ireland* to the *Cape of good Hope*: In all which, a *S. W.* Moon makes High-Water, and the same is reported to be on the *West Side* of *America*. But it would be endless to account all the particular Solutions, which are easie *Corollaries* of this *Hypothesis*; as why the *Lakes*, such as the *Caspian Sea*, and *Mediterranean Seas*, such as the *Black Sea*, the *Straits*, and *Baltick*, have no sensible *Tides*: For *Lakes* having no Commu-nication with the *Ocean*, can neither increase or diminish their *Water*, where-by to rise and fall; and *Seas* that communicate by such narrow *Inlets*, and are of so immense an Extent, cannot in a few Hours Time receive or empty *Water* enough to raise or sink their Surface any thing sensibly.

Vid. inf.
§ XI.

Lastly, The Cause of those extraordinary *Tides* in the Port of *Tunkin* in *China*, is proposed by Mr. *Newton* to be from the Concurrence of two *Tides*; the one propagated in six Hours, out of the great *South-Sea*, along the Coast of *China*; the other out of the *Indian-Sea*, from between the Islands in twelve Hours, along the Coast of *Malacca* and *Cambodia*. The one of these *Tides* being produced in *North* Latitude, is, as has been said, greater, when the Moon being to the *North* of the *Æquator*, is above the Earth, and less when she is under the Earth; the other of them, which is propagated from the *Indian-Sea*, being raised in *South* Latitude, is greater when the Moon declining to the *South* is above the Earth, and less when she is under the Earth. So that of these *Tides* alternately greater and lesser, there comes always successively two of the Greater, and two of the Lesser together every Day; and the High-Water falls always between the Times of the Arrival of the two greater Floods, and the Low-Water between the Arrival of the two lesser Floods. And the Moon coming to the *Æquinoctial*, and the alternate Floods becoming equal, the *Tide* ceases, and the Water stagnates: But when she has passed to the other Side of the *Æquator*, those Floods which in the former Order were the least, now becoming the greatest, that that before was the Time of High-Water now becomes the Low-Water, and the Converse. So that the whole Appearance of these strange *Tides*, is without any Forcing naturally deduced from these Principles.

Under-Cur-
rents in the
Downs, at
the Straits
Mouth, and
in the Bal-
tick; By Dr.
Tho. Smith
1758. p. 564.

VII. 1. In the *Offing* between the *North-foreland* and *South-foreland*, it run *Tide* and *half Tide*, that is, it is either ebbing Water or Flood upon the Shore, in that Part of the *Downs*, three Hours, (which is, grossly speaking, the Time of half a *Tide*) before it is so off at Sea. And it is a most certain Observa-tion, that where it flows *Tide* and half *Tide*, tho' the *Tide* of Flood runs aloft, yet the *Tide* of Ebb runs under Foot, that is, close by the Ground; and so at the *Tide* of Ebb, it will flow under Foot.

There is a vast Draught of Water poured continually out of the *Atlantic* into the *Mediterranean*, the Mouth or Entrance of which between *Cape Spartel*

or *Sprat*, as the *Seamen* call it, and *Cape Trafalgar* may be near 7 Leagues wide, the *Current* setting strong into it, and not losing its Force till it runs as far as *Malaga*, which is about 20 Leagues within the *Streights*. By the Benefit of this *Current*, tho' the Wind be contrary, if it does not overflow, Ships easily turn into the *Gut*, as they term the narrow Passage, which is about 20 Miles in Length. At the end of which are two Towns, *Gibraltar* on the Coast of *Spain*, which gives Denomination to the *Streights*, and *Centa* on the *Barbary Coast*: At which Places *Hercules* is supposed to have set up his *Pillars*. What becomes of this great Quantity of Water poured in this Way, and of that which runs from the *Euxine* into the *Bosphorus* and *Propontis*, and is carried at last thro' the *Hellepont* into the *Ægean* or *Archipelago*, is a curious Speculation, and has exercised the Wit and Understanding of Philosophers and Navigators. For there is no sensible rising of the Water all along the *Barbary Coast* even down to *Alexandria*, the Land beyond *Tripoli*, and that of *Egypt* lying very low, and easily overflowable. They observe indeed that the Water rises 3 Feet, or 3 Feet and half, in the *Gulf of Venice*, and as much or very near as much, all along the *Riviera of Genoa*, as far as the River *Arno*: But this rather adds to the wonder.

My Conjecture is, that there is an *Under-Current*, whereby as great a Quantity of Water is carried out, as comes flowing in. To confirm which, besides what I have said above about the Difference of *Tides* in the *Offing*, and at the Shore in the *Downs*, which necessarily supposes an under Current, I shall present you with an Instance of the like Nature in the *Baltick Sound*, as I received it from an able *Seaman*, who was at the making of the Trial.

3. He told me, that being there in one of the King's *Frigates*, they went with their *Pinnace* into the middle Stream, and were carried violently by the *Current*: That soon after they sunk a Bucket with a large *Cannon Bullet* to a certain Depth of Water, which gave Check to the Boat's Motion; and sinking it still lower and lower, the Boat was driven a-head to the Windward against the upper Current; the Current aloft, as he added, not being above 4 or 5 Fathom deep, and that the lower the Bucket was let fall, they found the under Current the stronger.

VIII. The *Euripus* is a Streight of the *Ægean Sea*, so narrow that a *Galley* can scarce pass thro' it under a Bridge, built between the *Citadel* and the *Donjon* of *Negropont*. But not only this place, where the Bridge is, is call'd the *Euripus*, but also 10 or 12 Leagues on each side of it, where the Channel being more large, the inconstant Course is not so sensible, as at the Foot of the *Castle*. For 3 or 4 Leagues on each side there are found 6 or 7 Gulphs, wherein this Water shuts it self up, to issue from thence as often as it enters there; and the Situation of these Gulphs contributes to the Oddness of this Flux and Reflux, of which the Moon seems to be the principal Cause.

There are 20 Days of each Moon, in which the Course of the *Euripus* is regular, and 10 in which it is irregular; that is to say, 5 Days before, and 5 Days after the *New* and *Full-moon*, the Course of it is irregular and strong. And then you see there the like *Phænomena* with those of the *Ocean* at *Bordeaux*.

The irregular
Flux and Re-
flux of the
Euripus, by
F. Jacq. Paul
Babin, n. 71.
p. 2153.

deaux. The Sea hath 2 Fluxes and Refluxes in 24 Hours, and every Day it retardeth almost an Hour. But there are 9 or 10 *Changes* of the *Course* of the Water during the remaining 10 Days of *Inequality*, unless it blow hard, for then the *Course* changeth not above 6 or 7 times. I once staid on the *Mill* which is under the *Bridge*, $1\frac{1}{2}$ Hour, and I saw the *Course* of the Water change thrice, though the *Wind* was pretty high, and the *Wheels* of the *Mill* turned as often diverse *Ways*. *M. de la Hogue*, a *Parisian Gentleman*, being curious, staid there almost a whole Day, with a *Janizary*; and the *Moon* being near the *Full*, he observed the same thing that happens in the *Ocean*. But tho' he designed to stay there full 24 Hours during the irregular Days, he was dissuaded from it, for fear of the *Turks*, that might take him for a *Spy*, and do him some *Mischief*.

The Water riseth not much above a Foot; and when it riseth, it runs into the Sea, and when it sinks, it flows into the *Chanet*, going towards *Constantinople*.

The small Gulphs that are on the left side of the Port of *Negropont*, are fill'd when the Water riseth; and emptied, running towards *Theffalonica* or *Constantinople*, when it descends. *F. Vabois* took notice of the same at *Constantinople*, viz. That the Waters of the *Black Sea* that come from *Constantinople*, drive the *Euripus* in its rising towards the main Sea, and that thereafter the Waters retire themselves towards the same place again from whence they came. The same Person also observed, that the swelling of the *Euripus*, which is irregular, lasted not above a good Quarter of an Hour, and the sinking thereof three good Quarters, tho' then the Water ran with more Rapidity, and seemed to us to come away in thrice as great Plenty, as when he saw it rise. I know not whether this proceeded from the *Wind*, not being able to assure you that this Effect is ordinary.

Between the Ascent and Descent there is a little Interval, wherein the Water seems to be at rest and stagnating, so that if there be no *Wind* stirring it, bits of Wood and Straw lye still upon the Water without Motion.

From what I have said, 'tis not difficult to reconcile the *Authors* that have written so differently of the *Euripus*. For those that have said, that there is nothing in it but what is seen in the *Ocean*, that is, two Fluxes and Refluxes in 24 Hours, have only observed it in those 20 Days of its Regularity. And the Ancients have not delivered a Falshood, when they say that there are 7 *Reciprocatations* in one Day, because that happens when the *Winds* trouble and retard the *Course* of the Water: And I do assure, by often reiterated Observations, that when 'tis still *Weather*, the Flux and Reflux is made even to 9 or 10 Times in a natural Day.

Extraordi-
nary Tides
about the
Orkneys,
communicated
by Sir Rob.
Moray, n. 98.
p. 6139.

IX. In *Fairay-Sound*, betwixt the Isles of *Fairay* and *Aetha* in *Orkney*, the Sea runneth North-East, for the Space only of 3 Hours in flowing, and 9 Hours South-west in Ebbing. This is the *Course* of the Tide only in the middle of the *Sound*, which is but one Mile broad.

Whilst the Sea runneth from West to East in flowing thro' *Westra Firth*, which is 8 Miles in Breadth, there are no greater *Surges*, than in any other place,

place of the Sea; and in a calm Day it is as smooth as any Lake, tho' there is constantly a great *Current*, in the *Flux* and *Reflux* of the Sea. Yet at the South-East End of a little Island on the S. E. side of *Westra*, and about a Mile from it, the Sea no sooner begins to run Westward in Ebbing, but there beginneth a *Surge* to appear, which continually encreaseth until the Ebb be half spent, and afterwards it decreaseth until it be low Water; at which time there appeareth no such thing. East and West from this great *Surge*, there are some few lesser *Surges* seen, which are gradually less toward the East and West. I having occasion to pass that way in a little Boat, when we had passed over the Eastmost *Surges*, and were beginning to ascend the biggest, upon the 10th of *April*, at one of the Clock in the Afternoon, the *Surge* before us was so high, that it intercepted the Sight of the Sun, and some *Deg.* of the Firmament above it. The *Surge* is about a quarter of a Mile in Length. When there is any Wind, which occasioneth the breaking of the Tops of the *Surges*, there is no passing that Way. The Current of the Tide is so strong there, that there is no need of Sails or Oars, save only to direct the Boat as doth the Helm.

X. In that Tract of Isles on the West of *Scotland*, call'd by the Inhabitants the *long Island*, as being about 100 Miles long from North to South, there is a Multitude of small Islands situated in a Fretum or *Firth*, that passes between the Island of *Eust* and *Herris*; amongst which there is one called *Berneray*, some 3 Miles long, and more than a Mile broad, the length running from East to West, as the *Firth* lies. At the East-end of this Island, where I staid some 16 or 17 Days, I observed a very strange Reciprocation of the *Flux* and *Reflux* of the Sea, and heard of another no less remarkable.

Upon the West-side of the *long Island*, the *Tides* which came from the S. W. run along the Coast Northward; so that during the ordinary Course of the *Tides*, the *Flood* runs East in the *Firth*, where *Berneray* lies, and the *Ebb* West. And thus the Sea ebbs and flows orderly, some 4 Days before the *Full Moon* and *Change*, and as long after the ordinary *Spring-Tides* rising some 14 or 15 Foot upright, and all the rest proportionably, as in other places; but afterwards, some 4 Days before the *Quarter Moons*, and as long after, there is constantly a great and singular *Variation*. For then, (a Southerly *Moon* making there the *full Sea*) the *Course* of the *Tide* being Eastward when it begins to flow, which is about 9 $\frac{1}{2}$ of the Clock, not only continues so till about 3 $\frac{1}{2}$ in the *Afternoon*, that it be *High-water*, but after it begins to ebb, the *Current* runs on still *Eastward*, during the whole *Ebb*, so that it runs Eastward 12 Hours together; that is, all Day long, from about 9 $\frac{1}{2}$ in the Morning, till about 9 $\frac{1}{2}$ at Night. But then, when the *Night Tide* begins to flow, the *Current* turns and runs Westward all Night, during both *Flood* and *Ebb*, for some 12 Hours more, as it did Eastward the Day before. And thus the *Reciprocations* continue, one *Flood* and *Ebb*, running 12 Hours Eastward, and other 12 Hours Westward, till four Days before the *New* and *Full Moon*; and then they resume their ordinary regular *Course* as before, running East during the 6 Hours of *Flood*, and West, during the 6 of *Ebb*. And this I ob-

Extraordinary
Tides in
the West Isles
of Scotland.
By Sir Rob.
Moray, n. 4.
P. 53.

served curiously, during my Abode upon the Place, which was in the Month of *August*, as I remember.

But the Gentleman, to whom the *Island* belongs at present, and diverse of his Brothers and Friends, knowing and discreet Persons, and expert in all such Parts of Sea Matters, did assure me, that whereas between the *Vernal* and *Autumnal* *Æquinoxes*, that is, for six Months together, the Course of *irregular Tides* about the Quarter-Moons, is to run all Day, that is 12 Hours, as from about $9\frac{1}{2}$ to $9\frac{1}{2}$, $10\frac{1}{4}$ to $10\frac{1}{4}$, &c. Eastward, and all Night, that is 12 Hours more Westward; during the other 6 Months, from the *Autumnal* to the *Vernal* *Æquinox*, the Current runs all Day Westward, and all Night Eastward.

At Tun-
queen, by
Mr. Fr. Da-
venport, n.
162. p. 667.

XI. 1. During my Stay at *Batsha*, having (without intermission) observ'd the daily Course of the Tides, my Advice is, that upon the several following Days of the Moon's Age in every particular Month of the Year, no *English* Commander should, upon any Occasion whatsoever, adventure over this *Bar*, unless he have a Pilot from the Shore, who undertakes to bring him in; or that he hath only Charge of some small *Bark* or *Junk*, that draws no more than 8 or 9 Foot Water.

In the $\frac{1}{7}$ } Moons, from the $\frac{3}{17}$ to the $\frac{7}{21}$ } days of the *Moon's Age* exclusively.

In the $\frac{2}{8}$ } Moons, from the $\frac{1}{14}$ to the $\frac{5}{18}$ } days of the *Moon's Age* exclusively.

and from the 27 to the *First* of the $\frac{3}{9}$ } Moon's exclusively.

In the $\frac{3}{9}$ } Moons, from the $\frac{11}{25}$ to the $\frac{15}{29}$ } days of the *Moon's Age* exclusively.

In the $\frac{4}{10}$ } Moons, from the $\frac{9}{23}$ to the $\frac{13}{27}$ } days of the *Moon's Age* exclusively.

In the $\frac{5}{11}$ } Moons, from the $\frac{7}{21}$ to the $\frac{11}{25}$ } days of the *Moon's Age* exclusively.

In the $\frac{6}{12}$ } Moons, from the $\frac{5}{19}$ to the $\frac{9}{23}$ } days of the *Moon's Age* exclusively.

And excepting on these 6 Days above-mentioned in every respective Moon, he may safely adventure over the *Bar* any Day, provided always that he mistake not the Time of the Tide, but come over at half Flood or better, tho' he may take notice that the best Tides will be about 6 or 7 Days after the Water's first beginning to increase, and the first Days of the Water's increase are,

In the	$\frac{1}{7}$	Moons,	on the	$\frac{5}{19}$	days	} of the Moon's Age.
In the	$\frac{2}{8}$	Moons,	on the	$\frac{3}{16}$	days	
In the	$\frac{3}{9}$	Moons,	on the	$\frac{13}{27}$	days	
In the	$\frac{4}{10}$	Moons,	on the	$\frac{11}{25}$	days	
In the	$\frac{5}{11}$	Moons,	on the	$\frac{9}{23}$	days	
In the	$\frac{6}{11}$	Moons,	on the	$\frac{7}{21}$	days	

The *Bar* it self being about a Mile and a half in Length, and no where, except in its first Entrance, exceeding half a Mile in Breadth, is very even, but yet affords considerably differing Sounding in the same Age and Time of the Tides, according to the Season of the Year, and which seems to be somewhat strange, hath the highest Tides in the Northerly *Monsoon*, as I have been inform'd by those who are seemingly best able to give an account thereof; and I must needs say, that the Trial I made on the *Bar* in *July*, 1678, did accord with what I understood from several of the Fishermen, and others as to that Month, which induced me to enter this *Information*, and coming over at half Flood, except on the Days afore-mentioned, as dangerous to come over in, there will be found according to the Age of the *Tides*,

In the $\frac{3}{4}$ Moons, from 16 to 21 feet Water.

In the $\frac{6}{7}$ Moons, from 19 to 24 Feet.

In the $\frac{9}{10}$ Moons, from 22 to 27 Feet.

In the $\frac{12}{1}$ Moons, from 17 to 22 Feet.

Always the higher the Flood, the lower the Ebb, so that according to the Strength of the Tides at *Low-water*, the *Soundings* are from 6 to 13 Feet.

On the first and second Days at the Water's Increase, the *Influxes* are very small and uncertain, but afterwards the *Tides* for 13 Days are constant in their *Course*, one *Flood*, and one *Ebbing* being compleated in 24 Hours time, equally sharing the Space of a *Lunar Circuition* of the Earth between them, and every *Flood* beginning nearest $\frac{1}{4}$ of an Hour later than the precedent *Flood*, and also

also considerably increasing in the height of the *Tide* every Day from the 3^d. unto the 6th and 7th Days of the *Water's Age*, on which 2 Days the Flood runs very high: But on the 8th Day (which may be accounted the last of the *Spring-Tides*) the Waters begin gradually to decrease again, retaining the same orderly Difference of Time in each Tide, until the next following first Day of the *Water's Increase*, when during 2 Days unsettledness, there is a shifting of the *Tides* in Respect of the Beginning of the *Flood* and *Ebb*; after which said shifting, a Constancy in their inverted Course is again retained in the above-mentioned Order for 13 Days following; as for Example,

On the 25th and 26th Days of the 4th Moon, (4th and 5th of June 1678, & in the latter End of *Aries*) being the first Days of the *Water's Increase*, the *Influxes* were very small, there happening on the 26th a falling back of the *Tides* about 13 Hours. But from the 27th (June 6th, which was the third Day of the *Water's Increase* after the last *Quarter*, until the 9th Day of the 5th Moon's Age, (June 18, 1678. & in $\approx$ 20.) I noted a very constant Course in the *Tides*, every Flood beginning with the rising of the *Moon*, and ending at its setting; the following *Ebb* in like Manner continuing during the Time of the *Moon's* Absence from this *Hemisphere*. But on the said 9th Day of the 5th Moon's Age (June 18, 1678.) being the first Day of the *Water's Increase*, their Motion was scarcely perceptible; on the 10th Day there was another falling back of the *Tides* nearest 13 Hours, and on the 11th Day, (which was the 3^d Day of the *Water's Increase*, after the first *Quarter* of the *Moon's Age*) the Flood having (as I said) shifted the preceding Day, took its Turn to begin at the *Moon's* Setting, and end at its Rising; and accordingly the *Tides* successively following assumed and kept a constant Regularity, the *Tides* being at highest the 16th of the *Moon*, (1678. June 24. & in middle of ν) which was the 7th of the *Water's Age*, until the 23^d of the said *Moon's Age* (July 1. 1678.) on which, being the first Day of the *Water's Increase*, the *Influx* was again scarcely discernible for its Smallness.

N. B. This *Bar of Tonqueen* is about 110 Degrees of *Longitude* to the East of *London*, and in the *Lat.* 20°. 50'.

On the 24th Day the *Tides* fall back, as I had found it twice before to have done on the same Days of the *Water's Age*, nearest 13 Hours, by which means the *Flood* on the 25th Day, which was the 3^d Day of the *Water's Increase* after the last *Quarter* of the *Moon*, now again commenced with the rising *Moon*, whereby it hath fallen out always to be *High-water* between Noon and the following Midnight, every Day during my Stay here. ($\Leftarrow$ Last *Quarter* 22 Days, & First *Quarter* 8 Days.)

So that it may pass into a Corollary, viz. In the 4th, 5th and 6th Changes of the *Moon* from the 3^d Day of the *Water's Age* after the last *Quarter*, to the 3^d Day of the *Water's Age* after the first *Quarter* of the following *Moon*, the *Water* begins to flow when the *Moon* riseth, and to ebb again when it setteth in the *Horizon*; and the contrary to the third Day of their Age after the last *Quarter*, excluding always their Motion on the two first Days of the *Water's Increase*, because of its Smallness and Uncertainty.

I am informed by the *Inhabitants* hereabouts, that this may hold for a Rule from the 2^d to the end of the 7th *Moon*, and that the Converse thereof holds true in the other 6 *Months* of the Year, viz. from the 8th to the end of the first *Moon*: According to which, the *Tides* will fall out to be at the highest in the *Evening* for 6 *Months* successively, and the other half Year in the *Morning*; that is to say, between *Midnight* and the following *Noons*. And tho' I cannot aver the Truth of it, yet I find that the *Tide* last Year in the 11th *Moon*, (which occasionally upon the Ship *Eagle's* departure hence, I took some notice of,) did fall out not disagreeing with what they affirm: And I am yet the rather induced to believe, that in every annual Revolution, there may be such a Constancy in this different Motion of the *Tide* appropriated to each Moiety of the Year, because that during my — Days Stay at *Batsha*, I have found the Predictions of the Natives confirmed by my own Observations of the *Tides* falling out to be High-water always between *Noon* and the succeeding *Midnight*, occasioned by the aforesaid falling back at the end of 15 Days; so that on every third Day of the *Water's Increase*, the Flood begins at the Hour whereon the Day before it ended.

To prevent Mistakes in the Accompt of the *Moons*, it may be sufficient to inform those who use this Port, that the first Change of the *Moon* after the 15th Day of *January*, O. S. is reckoned for the beginning of the Year, and that *Moon* being accounted the first, the rest follow in order until the Expiration of the 12th, which compleats their Year, except only in their *Leap-Years*, and then they have 13 *Moons*, taking in one extraordinary to make up the Deficiency of the *Moon's Epact* in their Accompt; in which Years the first Day of their *New-Years-Moon* falls out before the said 15th Day of *January*, as it did this Year 1678, upon the 12th, being *Leap-Year* with them, so that they reckoned two Months for one this Year; that is to say, the 2^d and 3^d *Moons*, after their *New-Year's Day*, they called 2^d *Moons*; for otherwise this present *Moon* which changed in *July* (the 8th) would have been the 7th; whereas now they count it but the 6th *Moon*, and accordingly do the *Tides* fall out. But this *Leap-Year* being past, the first *Moon* in the Year must be reckoned to begin on the Change next following the 15th of *January*, and all the other Changes counted successively, as before said, until the Intervention of another *Leap Year*.

2. The Effect of the *Moon* upon the Waters, in the Production of the *Tides* in this Port of *Tonqueen*, is the more wonderful and surprising, in that it seems different in all its Circumstances from the general Rule, whereby the Motion of the *Sea* is regulated in all other Parts of the *World* I have yet heard of. For first, each *Flux* is of about 12 Hours Duration, and its correspondent *Reflux* as long; so that there is but one *High-Water* in 24 Hours. Then there are in each *Month* two *Intermissions* of the *Tides*, about 14 Days asunder, when there is no sensible Flood or Rising of the Waters to be observed; but the *Sea* is in a Manner stagnant. Thirdly, That the *Increase* of the *Water* has its 14 Days Period between the aforesaid *Intermissions*: And that at 7 Days End makes the highest *Tides*, from which time the *Water* again gradually abates, and the Flood is weaker till it comes to a *Stagnation*; both *Increase* and *Decrease*

*A Theory of
the Tides at
Tonqueen.
By Mr. Edm.
Halley, ib. p.
685.*

ob-

observing the same Rule, in being exceeding slow in their Beginning and End, and swift in the Middle. *Lastly*, And which is most odd, the rising Moon in the one half of each Month, makes high Water, and the setting Moon in the other half. Those Particulars consider'd together with the Tables, shewing the Days of the *Water's Stagnation* in each Month, gave me a Light into the Secret of this strange Appearance, so as to be able to bring the hitherto unaccountable Irregularity of these Tides to a certain Rule.

And *First*, It appears by the latter of the two Tables, that the *Intermissions* of the *Tides* happen nearly upon those Days, that the Moon enters the Signs of *Aries* and *Libra*, or passes the *Æquinoctial*; which divides the Moon's Course nearly into 2 equal Parts, as well as the *Sun's*, and from hence it follows that the *Tropical Moons* in $\odot$ and ϖ , are those which occasion the greatest *Flux* and *Reflux*; and for the Rule of the Change of the Time of *High-water*, which Mr. *Davenport* calls a *falling back* of the *Tides*, the Example he hath given us, lets us know that the ϵ in *Northern Signs* brings in the Flood, whilst she is above the *Horizon*, so as to make *High-water* at her *setting*; and on the contrary, that whilst she is in *Southern Signs*, it flows all the time the Moon is below the *Horizon*, and so make *High-water* at her *rising*. But it is to be observed, that tho' the Motion pass swiftly from *South* to *North*, when she is in or near γ , and from *North* to *South* in or near *Libra*, yet the Motion of the Sea, which is the Cause of this *Tide*, is scarce discernable for 3 or 4 Days, when the Moon passes the said *Æquinoctial Points*; whence it appears, that tho' the Declination of ϵ , or her Distance from the *Æquinoctial*, be that whereby these *Tides* are regulated, yet the *Increase* and *Decrease* of the Water is by no means proportionable to that of the Declination of ϵ ; that changing swiftly where the *Increase* of the Water is observed to be most slow. It seems therefore, and I propose it as a probable Conjecture, that the *Increase* of the *Waters* should be always proportionate to the *versed Signs* of the double Distances of the Moon from the *Æquinoctial Points*; upon which *Hypothesis*, Fig. 58. will give an elegant *Synopsis* of the whole Matter. Let *AB* be the bottom of the *Bar of Tunking*; *CD*, a Perpendicular thereto, whereon to measure the several Depths of the *Water*; *CY*, $C\approx$, the mean Depth, which is that whereat the *Water* is *stagnant* upon the Moon's being upon the *Æquinoctial Points*; being commonly about 15 Feet: The $C\odot$ *Occid.* the *High-water Mark*, when the Moon is in $\odot$ or ϖ , being about 24 Foot. $C\varpi$, *occid.* the height of the *Low-water Mark*, when the Moon is in $\odot$ or ϖ , being about 6 Foot; so that the greatest Rise of the *Water* on the *Tropical Moons* will be about 18 Foot; then dividing $\gamma\odot$, and $\approx\varpi$, into two equal Parts, in *E*, *F*, on those 2 Points, as *Centers*, describe the two *Circles*, each of whose *Radii* are four Feet and a half, which being kept between the *Compasses*, naturally divide the said *Circles* in the Points, δ , π , $\ominus$, Ω , through the which Points, if you draw Lines parallel to the *Base AB*, they shall cut the Perpendicular *CD*, in the Heights of the high and low *Water-marks*, which will be at the Entrance of the Moon into the said Signs. So the greatest Depth of the *High-water*, when the Moon enters δ , π , Ω , $\times$, is but $17\frac{1}{2}$ Feet, and the least at *Low-water*, $12\frac{1}{2}$ Feet: But when she enters π , Ω , γ , $\approx$, the *High-Water*

Water depth is $21\frac{1}{2}$ Feet, the *low Water* is 8 Feet; as appears by the *Figure*. And this *Hypothesis* not only agrees with all that Mr. *Davenport* hath observed himself, or collected from the Natives, but hath been found to hold true since, in the Year 1682, by the ingenious Captain *Knox*, in his Voyage to this Port; so that there is no room to doubt of the Truth thereof. 1. By this Method may the Time and Height of the *Tides* be, with sufficient Certainty computed: But to philosophize thereon, and to attempt to assign a Reason, why the Moon should, in so particular a Manner, influence the Waters in this one Place, is a Task too hard for my Undertaking; especially when I consider how little we have been able to establish a genuine and satisfactory *Theory* of the *Tides*, found upon our own Coasts, of which we have had so long Experience.

XII. Mr. *Boyle* having recommended this Matter, among others, to a learned Physician that was sailing into *America*, and furnished him with a small *Hydrostatical Instrument*, to observe from Time to Time the Differences of Gravity he might meet with; this Account was returned him, that he found by the Glass, the Sea Water to increase in Weight the nearer he came to the Line, till he arrived at a certain Degree of *Latitude*; as he remembers, it was about the 30th; after which the Water seemed to retain the same *specifick Gravity*, till he came to the *Barbadoes*, or *Jamaica*.

XIII. Mr. *Hauton* hath now declared his Secret of making Sea-water sweet. It consists first in Precipitation made with the Oil of *Tartar*, which he knows to draw with small Charges. Next, he distills the Sea-water; in which the Furnace taketh up but little room, and is so made, that with a very little Wood or Coal he can distill 24 *French Pots* of Water in a Day; for the Cooling of which, he hath this new Invention, that instead of making the Worm pass through a Vessel full of Water (as is the ordinary Practice) he maketh it pass through one Hole, made on Purpose out of the Ship, and to enter in again through another: So that the Water of the Sea performeth the cooling Part; by which Means he saveth the Room, which the common *Refrigerium* would take up; as also the Labour of changing the Water when the Worm hath heated it. But then Thirdly, he joins to the two precedent Operations Filtration, thereby perfectly to correct the Malignity of the Water. This Filtration is made by Means of a peculiar Earth, which he mixeth and stirs with the distilled Water, and at length suffers to settle at the Bottom.

He maintains, that his distilled *Sea-water* is altogether salubrious: He proveth it first from Experience, it having been given to Men and Beasts, without any ill Effect at all upon them. Secondly, From Reason grounded on this, that that peculiar Earth being mixed with the distill'd Water, blunts the Points of the *volatile Spirits* of the Salt, and serveth them for Sheaths, if I may so speak, taking away their Force and Malign Sharpness.

XIV. It seems probable to me, that the Sea-water was the only Element created at the *Beginning*, before any *Animal* or *Vegetable* was created, or the Sun itself. But upon the Creation of these, the fresh Water had its Rise accidentally, because it owes its being in great Part (as I have elsewhere

The differing Gravities of Sea-water according to the Climates,
by ———
n. 18. p. 315.

A Way to make Sea-water sweet,
by Mr. Hauton, n. 67.
p. 2048. 2050

Sea-water made Fresh
by Dr. Mart. Lister, n. 196. p. 493.
De Font. Med. Angl.

shewn) to the Vapours of Plants, and the Breath of Animals; and the Exhalations raised by the Sun. Now that the Sea-water is made fresh by the Breath of Plants growing in it, I thus demonstrated: I took a long Glass Body, and having fill'd it pretty full with Sea-water, taken up at *Scarborough*, I put therein common Sea-weed (*Alga Marina*) fresh and new gathered, some with the Roots naked, and some growing on, and adhering to Stones: the Glass Body being full, I put thereon a Head with a Beek, and adapted a Receiver thereto, all without any Lute or closing of the Joints; from these Plants did distil daily (though in a small Quantity) a fresh, very sweet and potable Water, which hath no *Empegreuma*, or unpleasant Taste, as all those distill'd by Fire necessarily have.

This I take to be the most natural, most easie, and most safe way of having sweet Water from the Sea, and which may be of great Use, even to supply the Necessity of *Navigators*. And I do not doubt but there may be found other Plants growing in or near the Sea, which would yield fresh Water in much greater Quantities.

Wells of fresh Water near the Sea at Bermudas; by Mr. Rich. Norwood, n. 30. p. 566.

XV. We dig Wells of fresh Water sometimes within 20 Yards of the Sea, or less, which rise and fall upon the Flood and Ebb, as the Sea doth; and so do most of the Wells in the Country; though further up (as I am inform'd:) Wheresoever they dig Wells here, they dig till they come almost to a Level with the Superficies of the Sea, and then they find either fresh Water or Salt: If it be fresh, yet if they dig Two or Three Foot deeper, or often less, they come to Salt-water. If it be a sandy Ground, or a sandy crumbling Stone, that the Water soaks gently through, they find usually fresh Water; but if they be hard *Limestone* Rocks, which the Water cannot soak through, but passeth in Chinks or Clefts between them, the Water is salt or brackish.

To examine the Freshness of Water; by Mr. Boyle, n. 197. p. 627.

XVI. 1. When I remembred and consider'd, that (as I have found by various Trials) diverse metalline, and other mineral Solutions, could be readily precipitated, not only by the Spirit of Salt, but by crude Salt, whether dry or dissolv'd in Water; 'twas no very difficult Matter for me to think, that by a heedful Application of the precipitating Quality of the common Salt, one might discover whether any Particles of it, (at least in a Number any way considerable) lay concealed in distill'd Water, or any other propos'd to be examin'd. To this End I employ'd several Drugs, and those not all prepar'd by one *Menstruum*. And tho' Two or Three of my other Tryals had Successes, that I disliked not when I made them, yet that which at length I pitched upon as the most certain, and which therefore I meant, when I had the Honour to be sent for by his Majesty about the *Patentees Water*, was that which I think may be understood, as well as recommended, by this short Narrative.

I took some common Water distill'd in Glass Vessels, that it might leave its corporeal Salt, if it had any behind it, and put into a Thousand Grains of it one Grain of common dry Salt: Into a convenient Quantity, for Example, Two or three Spoonfuls, of this thus impregnated Liquor, I left fall a fit Proportion, for Instance 4 or 5 Drops, of a very strong and well filtrated So-

lution

lution of well-refined *Silver*, dissolved in clear *Aqua-fortis*; [for a Shift, common or *Sterling Silver* will serve the Turn:] And I made the Experiment succeed with Spirit of *Nitre*, instead of *Aqua-fortis*; upon which there immediately appeared a whitish Cloud, which, though but slowly, descended to the Bottom, and settled there in a white *Precipitate*. And to make the Experiment rather severely, than at all favourably, there was usually taken somewhat more than a thousand Parts of Water to one of Salt.

But I observed, that having let fall a few Drops of our *metalline Solution*, into the Liquor obtain'd from Sea-water, by the *Patentees* Way of sweetning it, there did not presently ensue any white Cloud or *Precipitate*, much less such an one as had been newly afforded by the Water that was impregnated with less than a thousandth Part of Salt. And if after some Time, there happened to appear (for 'tis not absolutely necessary it should) a little Cloudiness in this *factitious Liquor*, it was both flowlier produced, and much less, than that which appear'd in the impregnated Water.

Perhaps it may be proper, that I here observe (what is not wont to be taken Notice of) That divers *Solutions* of *mineral Bodies* may be *precipitated* by *Dilution*; that is, (to explain this Expression) when the *Solution* has Time enough allowed to diffuse it self through a great Quantity of Water, the *saline* Parts are thereby so *diluted* and weakned, that they are no longer able to sustain the *mineral Corpuscles*, they kept swimming before, but make with them, and the Water, a confused and subsiding Mixture; usually of a whitish Colour. This may appear, when the *Butter* of *Antimony*, being put into *common Water*, is thereby quickly and plentifully *precipitated* in the Form of that white Powder, that *Chymists* (not over-deservedly) call *Mercurius vitæ*. To which I may add, that I have also produc'd a Powder of that Colour, by pouring into *common Water* a strong *Solution* of *Tin Glass* made in *Aqua-fortis*. And by the same way we have *precipitated* the *Tincture* (or *Solutions* of the finer Parts) of *Jalap*, *Benjamin*, true *Labdanum*, *Antimonial Sulphur*, and divers other Bodies made in *Vinous Spirits*. If it were not for this Power, that *Water* has to weaken most *Solutions* of Bodies, I could have employed, instead of that *Silver*, either *Quick-silver* dissolv'd in *Aqua-fortis*, or *Lead* crude, or calcin'd in the same Liquor, or (which is more convenient) in strong Spirit of *Vinegar*; since these, and some others are found to be *precipitable* by *Salt Water* into whitish Powders. But tho' a very heedful Observer may, for a Shift, make Use of these *Metalline Solutions*, to guess at the Quality of *Water*, as to *Freshness* and *Saltiness*; yet the *Precipitation*, that is made by *Dilution*, is not difficult to be distinguish'd from that which is perform'd by a true and proper *Precipitant*, (as in our Case by the *common Salt*, that is harbour'd in the Pores of the *Water*) both by the Quickness of the Effect, and the Copiousness of the white Substance produc'd, and on both these Accounts is very much inferior to it; as may evidently appear in the very different Effects, that our *Solution* of — had upon the *Patentees Water*, compar'd with those it had upon *Water* impregnated with a thousandth Part of Salt, and upon divers common *undistilled Waters*.

But to return; The Usefulness of this Experiment is not to be estimated only by the *Examen* it helps us to make of *dulcify'd Sea-water*, but much more by the Estimate, that by its means may be made of *natural fresh Waters*, whether of *Springs, Rivers, Clouds, Lakes, Wells, &c.* For it being generally granted, that those Waters, *ceteris paribus*, are the best, as well for the Wholsomeness, as diverse OEconomical Uses, as *Washing, Brewing, &c.* that are freest from *Saltiness*, which is an adventitious, and in most Cases, a hurtful Quality of *Waters*; by our way of *examining* these Liquors, a heedful Eye may in a Trice discover, whether there be any latent Saltiness in them, (as most Waters imbibe from the Soil they have travers'd or do stagnate in) and may enable one, especially by the Help of a little Practice, to give a near Guess, how much one Water is fresher than another, as I have purposely try'd, with Pleasure, in differing Waters, that are ordinarily drunk, even by considerable Persons. And if once you have attentively marked, what Change 4 or 5 Drops, for Instance, of our discovering Liquor will make in *Two* or *Three*, or some other small determinate Number, of *Spoonfuls* (or rather of *half Ounces*) of *Water*, 'twill not be difficult for a heedful Observer, keeping the same Proportion between the two Liquors, to make a near Estimate, whether any natural Water propos'd to him, have a greater, an equal, or a lesser Degree of Freshness or Saltiness, than that Water that he has chosen for his Standard; and how much, in Case there be a Difference, the propos'd Liquor is less or more free from Saltiness than the other.

And that (to add this upon the by) such a Difference in a Liquor of such frequent inward Use as *Water* (which is the *Basis* of *Beer, Ale, Mead*, and some other common *Drinks*) may have considerable Effects upon human Bodies in Reference to *Health*, may be probably argued from the differing Effects that Waters more or less impregnated with Salt, have upon diverse other Bodies. Since most *Pump-waters*, for Instance, will not boil Peas and Beef, and some other Aliments, near so well as Spring-water or Rain-water, which are usually softer, and more free from the Saltiness we speak of. 'Tis commonly known to Barbers and Laundresses, that the same *Pump-water* will not so well and uniformly, or without little Curdlings, dissolve Washballs and Soap, as *Rain-water* and some *Running-waters* usually will: Nay, when I was curious of *tempering Steel*, I remember, 'twas confess'd by the skilfullest Artists I made Use of, that some Tools (as *Gravers &c.*) made of that hardest of *Metals*, would receive a differing *Temper* if they were quench'd in *Pump-water*, from that, which the like Extinction in Spring-water, or River-water would give them.

I might add on this Occasion, That, whereas Experience has inform'd several Persons, who have consulted it, that diverse *Medisinal Waters*, that are presumed to own their Virtues to the Participation either of *Metalline*, or of other *Mineral* Bodies, do, upon *Tryal*, appear to leave sometimes little, and sometimes nothing behind them, except a kind of *common Salt*; our Precipitant may much assist Men to discover, whether a *Mineral Water* propos'd to be examin'd, do, or do not contain, such a *Salt*, and if it do, whether it contain it copiously.

copiously or no. This I have tried upon more than one of our *English Mineral Waters*, and thereby found in a Trice, that one, that is reputed of another Nature, contained pretty Store of *saline Matter*; and that another, which is still, for ought I have learned, of an unexamin'd and unknown Nature, is impregnated with a surprising Plenty of *saltish Substance*; but how, and with what *Cautions* our *Precipitant* may be most usefully employ'd, about the *Examen* of medicinal and other *mineral Waters*, belongs not to this Place. Upon which Account, I forber to declare the Use I have sometimes made of our *Precipitant*, in examining the *fresh Urine* of Men, the *Serum* of human Blood, and other Bodies belonging to what the *Chymists* call the *Animal Kingdom*.

I have not, for certain Reasons, ascribed to our Method of examining *Waters* a greater Nicety, than to be able to discover one Part of Salt in a thousand of *Water*, that Proportion being great enough to recommend it, and express'd by a round Number easy to be retain'd in one's Memory: Yet I would not have it thought, but that, if it were requisite, our *Method* may make more nice Discoveries. For having sometimes, for Curiosity's Sake, put one Grain of Salt into no less than 1500 of distill'd *Water*, we could manifestly, tho' not quite so conspicuously, as before, make it appear by our way, that even this so lightly impregnated Liquor was not devoid of Salt, but had more of that in it, than some of the *Patentees Water*, that I kept by me, had; nay, I once found, that a Grain of dry Salt being dispers'd thro' 2000, and another Time, that being dissolved in 300 times its Weight of the same kind of Liquor, so inconsiderable a Proportion of Salt was plainly discoverable by our *Precipitant*.

It may be objected, That whereas the *Experiments*, hitherto mentioned, have been try'd only upon *Waters* impregnated with gross or corporeal *Sea-Salt*; this perhaps may not hinder, but that they may be imbued with the *Spirits* of marine Salt, which, by reason of their Activity, may be as unhealthful to the *Drinker*, as the grosser Salt itself. But tho', to this Surmise, I might answer, that a very small Proportion of *Spirit of Salt*, may in many Cases make the *Water* season'd with it, rather medicinal than unwholesome, yet I shall answer more directly to the Objection, by saying, that to manifest its not being well grounded, I took above 1000 Grains of distill'd *Water*, and instead of corporeal Salt, put to it one single Drop of moderately strong *Spirit of Salt*, for I had much stronger by me, that I purposely declin'd to employ, and having shak'd it into the *Water*, I let fall into a Portion of this unequally compos'd Mixture, some Drops of our Solution of Silver, which presently began to precipitate in a whitish Foam, insomuch, that for ought appear'd to the *Eye*; this Tryal succeeded better, than if the *Water* had been impregnated with but 1000th Part of corporeal Salt. The like *Experiment* was made with the *Patentees Water* instead of the other. And to pursue this Tryal a great Way farther, I had the Curiosity to diffuse one Drop of *Spirit of Salt* into 2000 Grains of distill'd Rain-water; and upon letting fall some Drops of our *Precipitant* into it, I found that the Success well answer'd my Expectation.

And then, to urge the Tryal yet farther, I added as much of the same distill'd Rain-water, as by a modest Conjecture made it amount to at least half.

half as much more. So that one Grain of Spirit of Salt had a manifest Operation, tho' not quite so conspicuous as the former, upon above 3000 Grains of Water, whose Immunity from common Salt we tried apart. And that a Drop of the saline Spirit, we made Use of, did not equal in Weight a Grain of dry Salt, I found by this, that having let fall into a counterpois'd Piece of Glass, ten Drops of that Spirit, I found them to want near half a Grain of 9 Grains Weight.

The like Tryal I made by substituting above 1000 Grains of Rain Water in the Room of the like Quantity of distill'd Water.

It is the Opinion of some Seamen, and of a Person for whom I have a profound Respect, that Water ought to have a little Saltishness to preserve it; if this be really a desirable Quality in our artificial Water, it may in a Trice be supplied with as much Saltiness, whether corporeal or spiritous, as shall be required, and consequently, as will bring it to be equal in that Quality to the common Water of Rivers or of Springs. And perhaps 'twill not be impertinent to add on this Occasion, that in some Places, especially lying in hot Climates, it may sometimes be of good Use to know, whether on the Account of the Sun's Heat, or that of the subterranean Regions of the Earth, the Rain-water is impregnated with volatile, not acid, Spirits, like those that are distill'd from Urine, and which I have, for Curiosity's Sake, obtain'd from a mineral Body, native sal-armoniack; upon which Account I made a Tryal that inform'd me, that if 5 or 6 Drops of strong Spirit of Urine, whose Drops I observ'd to be but small, were shaken into a 1000 Grains at least of distill'd or Rain-water, impregnated but with one of Salt, our Precipitant would make a Discovery of some Saltishness in the Liquor. And if it were neither to be admired nor censured, if the Patentees Water should sometimes shew a Change, when our Precipitant is plentifully put, or long kept in it, especially that Change being a more light one, than that I came from speaking of: Since for ought I have yet observed, not only such undistill'd Waters are generally allowed to be freely potable, but even those that Nature herself distils, are not always quite devoid of Saltiness.

For I have found Rain-water, that I caus'd carefully to be sav'd, after the House-tops had newly been well wash'd with former Rain, to grow a little troubled, if any Store of our Precipitant were kept for some competent Time in it. And being gently distill'd off, it left a Residence, which, with a little of our Solution, afforded a far more suddenly made and copious Precipitate, than had been produc'd with the like Quantity even of Pump-water it self. And tho' I have met with Rain-water, that was more free from Salt than any Spring or River-water, that I remember I have examin'd; yet having, for Curiosity's Sake, made Tryal of Snow-water, which, if the Weather had been somewhat milder, would have been Rain; this Liquor, I say, which is thought to afford the lightest Water of all natural ones, I manifestly found, by our Way of examining it, not to be devoid of Saltiness.

It has been surmis'd by some, that even a moderate Action of the Fire upon Water will make it brackish and putrify: But that the Patentees Water is not brackish, appears by the foregoing Tryals; and that it is more free from Saltiness, than most of the Waters, Men do without Scruple, drink: And that it may

may keep sweet longer than is necessary in a Ship, that can from time to time within a few Days, supply it self with *fresh* out of the *Sea*, may be gathered from these 2 Things; The first is, That I caused a Pint of it to be *hermetically* seal'd in a Vial, whereof I left, by guess, about a 3^d Part empty, and having about 6 Weeks after, held this Vessel against the *Light*, I found the *Water* to be clear and limpid; tho' I did not judge it had deposited so much as the Tenth Part of a Grain of *Feculency*. And having opened the *Seal*, and taken out a little of the Liquor, I did not find it alter'd either as to *Smell* or *Taste*. The *Second* is, that I have kept a *Bottle* of it in the same unstopt Vessel near 8 Months, and yet it continues sweet and well condition'd. And if that which is call'd *Crudity* in *Water* does consist, (as probably it often does) in certain gross Particles that are mingled with the purely aqueous ones, it is likely, that the Action of the Fire may divide and dissipate these into minuter Particles, and thereby destroy the Texture that makes them hurtful; and by causing innumerable Tumblings and Rovings amongst the more earthy Particles, give them Opportunity to make little *Coalitions*, whose Weight precipitating them to the Bottom, frees the pure *Water* from them.

And because 'tis but too probable that the *Unwholesomeness* of divers *Waters* proceed, not only, or perhaps not so much, from bare *Crudity* as from a great Quantity of grosser *Particles*, that are not easy to be rais'd, because of their being combin'd with fixt and earthy ones, that swim up and down in the *Water* they impregnate, as *Silver* or *Mercury* does in a *Solution* made with *Aqua-fortis*, or rather as the Particles of Salt do in *Pump-water*, and many other common *Waters*: On this Account, I say, the *Patentees* Invention may very much correct such *Waters*, since by their Way of sweetning those Liquors, the truly aqueous Parts are not only freed from the saline ones, but from the mineral and other gross and hurtful *Corpuscles* that may have lain conceal'd in the Liquor. As may be argued from hence, that having purposely in the gentle Fire of a digestive Furnace, slowly distill'd off a Pound of the *Patentees* *Water*, it left us in the *Cucurbit* so light and thin a *Feculency*, that the Bottom of the Glass seem'd to be rather sullied than cover'd by it; and I did not judge, that the whole *Feculency*, if we could have got it out, would have amounted to so much as 2 Grains.

Perhaps it was upon such Reasons, that the last *Great Duke* of *Tuscany*, when he drank *Water*, prefer'd for *Wholesomeness*, that which was distill'd to that which was not; and if herein that learned Prince, and those of the same Opinion were not mistaken, it will highly recommend the Usefulness of the *Patentees* Invention to Mankind. For there are Multitudes of *Waters* that are not considerably *brackish* to the Taste, that yet, by reason of some unheeded *Saltiness*, as in most *Pump-waters*, more frequently by reason of *Crudity*, are not only unfit, or at best, less fit for divers *Economical* Uses, as *Washing*, *Boiling* of some *Meats*, &c. but are very unwholesome; sometime to a Degree, that makes them mischievous to whole *Communities*, and perhaps *Nations*. I remember I have seen a notable Instance of this in those huge and unsightly Tumours about the *Throat*, which are observed by *Travellers* to be exceeding common; among those that inhabit the lower Tracks of Ground that lie between the

the *Rhetian, Helvetian*, and some other neighbouring *Mountains*; which monstrous *Swellings* are generally imputed to the *Snow-waters* that flow from the *Mountains*, and make the usual Drink of the meaner Sort of People; whence 'tis observ'd, that Persons of better Condition, who drink *Wine* more than *Water*, are either not at all, or far less troubled with these *disfiguring Goitres*, as they call them. But much more notable *Instances* to our present Purpose are afforded me, by that great and yet living Traveller, M. *Tavernier*, Baron of *Aubonne*, who speaking of a Nation of *Cafres* or *Negroes*, that come sometimes to trade with the *Portugueze* from a remote Part of *Africk*, informs us, 'That the *Water* of their Country is very bad, which is, (says he) the Reason that their *Thighs* do swell, and it is a Wonder to see any of them free. Nay, which is far more, where he speaks of the *African Kingdom*, or Empire of *Monomotapa*, he has this memorable Passage, 'The Natives never live long, by reason of the Badness of the *Waters* in the Country. For at the Age of 25 they begin to be dropical, so that 'tis a great Wonder if any among them live above 40 Years.

These People might probably be much reliev'd, and be brought to live as long as other Nations, if they had so compendious a way as that of the *Patentees*, to provide themselves plentifully with *Waters* whose *Crudity* is corrected, its grosser and heavier Parts separated, and its *Brackishness* destroy'd by the Fire, as its Action is regulated and help'd by their Invention.

The Experiment, mention'd in this Paper, was try'd at a Meeting of the R. S. Feb. 17. 169 $\frac{1}{2}$. by Dr. *Sloane*, with a Success answerable to the Assertions of the honourable Author, and that a Drop or two of Spirit of Salt, mixt with common *Water*, would be by the same Method discovered.

By Dr. Hook,
ib. p. 639.

2. At a Meeting of the R. S. Mar. 2. 169 $\frac{1}{2}$. Dr. *Hook* read a Lecture concerning a Method of his own for the discovering the smallest Quantity of Salt contained in *Water*, from a Principle of *Hydrostaticks*; and after his Discourse thereof, he produced the Apparatus, which he had prepared to exhibit the same before the Persons then present.

The Method of doing which Operation was by means of a large Poise of Glass, somewhat of the Shape of a Bolt-head, the Ball of which B was about 3 Inches Diam. but the Stem or Neck thereof CC, was not above $\frac{1}{4}$ of an Inch. This was so poised by Red-Lead put into it, as to make it but a little heavier than fair or fresh *Water*. Then this Poise was suspended by the small Stem to the End of a slender Beam, A, which was very tender, and being not overcharg'd with Weight, would turn with a small Part of a Grain. This Beam was hung on a steady Frame, and the Poise hanging at one End of the same, covered with the *Water* to a certain Mark or Division made on the small Neck, at D, it was so counterpoised by some small Weights put into the opposite Scale of the Balance, F. Then the Weight of the *Water* contained in the Cistern or Vessel, EE, into which the Poise was immerfed, (being first known, a 2000th Part of its Weight, was taken of common Salt, weighed out, and put into the whole 2000 Parts of the *Water*, which, by being stirred, soon dissolved. Then the Poise, suspended as before, was view'd and examined by many then present, and they manifestly saw, that near half

half an Inch more of the Neck emerged out of the *Water* so seasoned, than did before the 2000th Part of *Salt* was dissolved therein.

This was only one Use of this Method of discovering very small *Alterations* in the *Constitution* of *Bodies*, the same *Author* having long since, namely, Octob. 25. 1677. shewn to the same Society a Method of discovering divers *Alterations* much more curious, namely to the 176000th Part of its *Weight*.

XVII. There is an old Spring in the Diocess of *Paderborn* in *Westphalia*, which loses it self twice in 24 Hours; coming always after 6 Hours back again with a great Noise, and so forcibly as to drive 3 Mills not far from its Source. The *Inhabitants* call it the *Bolderborn*, as if you should say, the *Boysterous Spring*. *An Ebbing Well in Westphalia, by Dr. Wm. O-liver, n. 104. 7. p. 127.*

XVIII. *Lay-well*, near *Torbay*, is about 6 Foot long, and 5 Foot broad, and near 6 Inches deep, which ebbs and flows very often every Hour, visibly enough. I am informed, 'tis most constant Winter and Summer, tho' I am apt to think it moves faster in Winter, when the *Well* is fuller, than in Summer: Because when I observed it first, (in July 1693) I think it flowed somewhat quicker than I found it did on my second *Observation*, toward the End of *August* following; for the *Water* was then considerably shrunk in the *Well*, notwithstanding we had for about a Fortnight much Rain: And tho' when once it began to flow, it performed its Flux and Reflux, in little more than a Minute's Time; yet I observed it would stand at its lowest Ebb sometimes two or three Minutes; so that it ebbed and flowed by my Watch, about 16 Times in an Hour, and sometimes I have been told 20. As soon as the *Water* in the *Well* began to rise, I saw a great many Bubbles ascend from the *Bottom*, but when the *Water* began to fall, the Bubbling immediately ceased. I measured its high and low Water Marks, and found them between 5 and 6 Inches distant; not of Perpendicular Depth, but as it spread it self on a broad Stone, as the Sea does on a Beach or Shore. Tho' I am apt to think its Perpendicular Height would be as much, or more in that Time, were its Out-let damm'd up to try an Experiment; for as it rises, it runs out with a small Stream, which is greater or less, according as the *Water* in the *Well* rises and falls. *An Ebbing Well near Torbay by Dr. Wm. O-liver, n. 104. p. 909, 910.*

That it has any *Communication* with the *Sea* is not manifest, nor is the *Water* brackish at all. The whole Country adjacent is very hilly all along the Coast, insomuch that from *Brixham* to the Top of the Hill, is about a Mile and half; and the *Well* is about half way up the Hill, (which hereabout is somewhat uneven and interrupted) and comes out at a small Descent, yet considerably higher than the Surface of the Sea.

I tried it with an *Oaken Leaf*, as soon as I saw it the first Time, but could not find it change Colour. I drank of it, 'tis very soft and pleasant, has no manner of Roughness in it, and serves for all manner of Uses to the Country People in their Houses; they also use it in Fevers, as their ordinary Diet-drink, which succeeds mighty well.

The Zirchnitzer Sea in Carniola described by Dr. Brown, n. 54. p. 1083. n. 109. p. 194.

XIX. 1. Having cross'd the River *Dravus*, and pass'd Mount *Luibel* in the *Carnick Alps*, by that noble Passage cut thro' the Rocks, and vaulted like that of *Pausilyppe* near *Naples*, I went to *Brounizza*; 2 Leagues from whence, and beyond the Hills, is the *Zirchnitzer Sea*, receiving that Name from *Zirchnitz*, a Town of about 300 Houses.

This Lake is near 2 German Miles long, and one broad. On the South side thereof lies a great Forest, and on the North-side the Country is flat; but the whole Valley is encompassed with high Hills, at some little Distance from it. But I saw no Snow upon them, tho' upon other Mountains in the Country, I observed Snow in *June*. Upon Hills on the side of great Lakes, the Snow lies not so long as upon Hills more distant.

This Lake is well fill'd with Water for the greatest Part of the Year, but in the Month of *June* it sinketh under Ground, not only by *Percolation*, or falling thro' the Pores of the Earth, but retireth under Ground through many great Holes at the Bottom of it; the little, if any, that remains in the hilly or rocky Part is evaporated: And in the Month of *September*, it returns by the same, and in a short time covers the Tract of Earth again, but I cannot determine the Space of Time to a Day. This Return and Ascent is so speedy, and it mounteth at the Holes with such Violence, that it springs out of the Ground to the Height of a Pike. The Water that spouts seems somewhat clear in the Air, but being spread about, looks as formerly in the Lake.

The Holes generally are stony, not in soft or loose Earth; yet in one or two Places the Earth hath been known to sink, and fall in, particularly near a Village call'd *Sea-dorf*. They are of different Largeness and Figure; some perpendicular at the Beginning, and then oblique; others oblique at first, scarce two exactly alike. Such Holes I have seen in other Parts of *Carniola*, and in other Countries also. We have a Hole call'd *Elden Hole*, not made by Art, but naturally, in the Mountains in the Peak Country of *Derbyshire*, above 80 Fathoms deep. The great Holes are the same every Year, but possibly part of the Water may sometimes find or make new Passages thro' the Crevices and cribrous Parts of the Field.

When the Water goeth first away, they see it in these Holes for a while, but afterwards it descends lower out of their Sight.

This Piece of Ground in the time of the Retirement and Absence of the Water is not unfruitful, but by a speedy and plentiful Production of Grass, yieldeth not only a present Sustenance for the Beasts of the Field, but a good Provision of Hay for the Cattle in *Winter*.

The Lake is not only thus fill'd with Water, but every Year well stored with Fish. The Prince of *Eckenberg* is Lord of it, and of much Country thereabout. But upon the retiring of the Water all have Liberty to fish; and the Fishermen standing up to the Waste at the Holes before mentioned, intercept the Passage of the Fish, and take a very great Number of them, which otherwise would be secure for some Months under the Earth, and not fail to return in *Sep*. But at that time the Prince will not permit them to make any such Attempt.

The Fish of this Lake have a closer Habitation than those of any other I know; for they pass some Months under the Earth, and a good part of the *Winter* under Ice. I could not learn that there were any Otters in this Lake, which

which otherwise must probably have taken the same Course with the *Fish*, not that there were any remarkable extraneous Substances, any Vegetables, or unknown Fishes brought up by the Water, but those which come up are of the same Kind with those which descend.

The Bottom of the *Lake* is not even, nor near about the same Depth, but sometimes 2 Foot, and then suddenly 20 Yards deep. And because the *Fish* haunt the deep Places more than the Shallows, they have given Names to the seven chiefest Cavities or Valleys in the *Lake*.

The Water is not always at the same Height, but somewhat differing according unto Rains, Snows, or Drought; and they are sensible of its height by the Tops of the Hills in it, and its spreading toward *Zirchnitz*, but it alters not very much till it begins to go away.

No River enters it, but only inconsiderable *Rivulets* on the South and East side; nor hath it any other Discharge known, but by the Holes.

There are also divers Caverns and deep places in the Country of *Carniola*, even where there is no Water.

Between *Sea-dorf* and *Nider-dorf*, the Ground sometimes sinks in several Places upon the sudden retiring of the *Lake*; and the aforesaid Prince of *Eckenberg* was once so curious, as to descend into one *Hole*, thro' which he passed under a Hill, and came out on the other side; as I was informed by *M. Andreas Wiser*, the present Judge of *Zirchnitz*, and also by *Johannes Wiser*, who hath formerly held the same Place.

The Country is high about the *Lake*, but the *Lake* is not high in Respect of the Country near it, but low.

The Snow falls not till after the *Lake* is return'd.

This *Lake* probably may hold Dependance of, and Communication with some subterraneous great *Lake*, or Magazine of *Water* belonging to these hilly Regions, which when full, and running over, may vent it self with Force and Plenty into this Field; and when scant of *Water*, absorb and drink in the same again; the *Water* of the *Lake* returning but from whence it came, having no River running out of it whereby to be discharged.

I went also to a noted Stone, commonly call'd the *Fishers-Stone*, which hath somewhat of the Use of the *Nile-scope-pillar* at *Grand Cairo*. It is a large Stone upon one of the Hills, or elevated Parts of the Field, which whensoever it appears above *Water*, the *Fishermen* being upon the *Lake*, take notice of it, and know thereby, that in a few Days the *Water* will retire under Ground. For after the filling of the *Lake* in *Sep.* the *Water* never decreaseth so low again, as to let the *Fisher-stone* appear, till it begins to retire under Ground.

2. This *Lake* was by the *Antients* call'd *Lugea Palus*, by the Moderns, *Lacus Lugeus*, tho' at present its *Latin* Name be *Lacus Cirknicensis*, in *Higb-dutch*, *Zirchnisersee*, and in our *Carniolan* Tongue *Zirknisco Jeseero*. Why it was so called of old, is unknown, or very uncertain, but the *Original* of the present Name is more sure, it being derived from the adjacent Town of *Cirknitz*; and that had its Name from a *Chapel* of the *Virgin Mary*, which at first stood alone, but now the Town is built round it. This *Chapel* was no great Edifice at first, and therefore was called the little *Chapel*, which in the *Language*

By M. J. Weichard, Valvafor. n. 191. p. 411.

of the Country is *Zirkviza*; whence the Lake was named *Zirkvisco Jesero*, or the *Chapel-Lake*, but now by Abuse, *v* being changed into *n*, *Zirknisco Jesero*.

It is distant from the Capital City of the Province *Labac* 6 German Miles, it is a good German Mile long, or better than 4000 Geometrical Paces, and is about half as much in breadth. Its ordinary Depth is 10 Cubits, its least 5 or 6, rarely 3, but its greatest is 16 Cubits. It is every where surrounded with woody Mountains, which on the South and West-side are very high, and 3 Miles broad, running far in length into the *Türkisch* Country, and afford nothing but horrid stony Deserts, overgrown with Trees. On the North and East-side, there is between the Mountains and the Lake, a small Territory, which tho' narrow, is nevertheless pleasant, and is inhabited by one Town, 3 Castles, and 9 Villages, and adorned with 20 Churches; as may be seen in the Map, which was drawn by my self upon the Place with all possible Care.

In the Mountain call'd *Javornik*, standing near the Lake, there are two Holes, or exceeding deep Precipices, in which many thousand wild Pigeons roost all the Winter; entring in *Autumn*, and coming out with the first of the *Spring*: What they live upon in these Caverns is unknown, but I take it to be the nitrous Sand. In another Hole call'd *Slivenza*, 'tis the Belief of the Country People, that the *Witches* hold their Assemblies, because that several times Lights like *Ignes fatui* are observed there. On the Top of this Hill is a Hole of an unknown Depth, out of which there often breathe out noxious Hail; and for this Reason the Priest of *Zirknits*, every *Whitson-Monday*, goes to the Hole in Procession, and uses over it a certain Form of *Exorcism*.

There run into this Lake continually 8 Rivulets. The two least are call'd *Bellebrech* and *Tresenz*, the 3^d is the Fountain *Oberch*, out of which abundance of Water gushes with great Force; the 4th, 5th, and 6th, call'd *Steberziza*, *Linsenziza*, and *Seromschiza*, may for their Bigness deserve the Name of Rivers; the 7th *Martinschiza*, breaks out at a Cleft in the Rock: The last called *Cirknizer-bach*, is a pretty large River.

Now this Lake being every where surrounded with Mountains, and nowhere running over, Nature has given it two visible Channels, or stony Caverns, call'd *Velka Karlouza* and *Mala Karlouza*, by which the Water runs under the Mountain; and a 3^d concealed subterraneous Passage, which without doubt communicates with the other 2 under Ground (as I shall hereafter prove.) These having run half a German Mile, come out at the other side of the Mountain, near the Chapel of St. *Cantian*, as I have faithfully drawn it, in a Desert-place, at a stony Cave A, and become the River called by the Inhabitants *Jesero*, that is, the Lake. This River *Jesero* marked B, is reasonably big, and having run half a quarter of a Mile, enters a wide stony Cavern I, running slowly under the Hill for the Space of a good Musquet-shot; then coming out again on the other side, after it has run thro' a small Plat m m, it enters a 3^d Cavern or Grotto C, wherein having passed 50 Paces, one may say *Siste Elator, ne plus ultra*, for it runs no longer peaceably as before, but with great

great Noise and Roaring falls down a very much inclined Channel of Stone, so that neither I nor any else durst follow it farther. In *June* 1678. I went my self in a small Fisher-boat under the Mountain, through the Cave *I*, and entred the *Grotto C*, till I came to the aforesaid Falls, without any Danger or Trouble, the Passage being wide enough.

It must be noted, that the Valley wherein this River *Jesero* runs, is exceeding steep, but the Plat of Ground *m m* is plain and stony, of an Oval Form, and is surrounded with (as it were) a very high Rampart *K K K*, so steep that it would be impossible for a Cat to climb out of it, unless at one Place, whereat a Man may make a Shift to go up and down, tho' not without Peril of his Life; the Way being in some Places not above three or four Inches, and no where above 6 Inches wide. In the Year 1684, I went down here in Company with a *French* Gentleman, but the Water being up, and we wanting a Boat, we could not go under the Hill, nor enter the *Grotto C*; so we returned, and with great Difficulty descended by a steep and narrow Passage at *D*, and came to a Cave bigger than any Church, through which the River *Jesero* runs. Here we found several Figures of Stone, the Workmanship of Nature, and strange Holes and Caverns in the Earth; but by reason the River was then up, we could go no farther. At other Times when the Water is down, one may go with lighted Torches a great way under Ground; and it is said there are here very odd Figures formed by the Petrified Water: Among the rest one resembling a Weaver at Work, of which the Country People want not their Superstitious Traditions.

But to return to our Lake; I say, that about the Feast of *St. James's Tide*, and sometimes not till *August*, the Water runs away, and it is Dry: But it fills again, and most commonly in *October* or *November*, yet so as not to observe any certain time; for sometimes it has been dry twice or thrice in a Year: as in the Year 1685 it was dry in *January*. Again the Water began to draw off, on the 15th of *August St. N.* and it was quite clear by the 8th of *September*; and this present Year 1687, it has been thrice empty, which makes the Fishing very poor and inconsiderable. Sometimes again, tho' but seldom, it has happened to be three or four Years together full of Water, and then is the best of the Fishing. But it never yet was observed that this Lake was dry for a whole Year together.

The Right of Fishing in this Lake, upon certain Terms agreed on, does at this time belong to the Lordships or Castles following, 1. to *Häasberg*, 2. *Steegberg*, 3. *Laas*, 4. *Sebneperg*, 5. *Avesperg*, 6. to *Sitticium*, which is a Monastery of *Cistercian Monks*.

There are 3 Islands in this Lake, viz. *Mala-Goriza* and *Velka-Goriza*, which are uninhabited: The 3^d is a very pretty Island called *Vornek*, that is reasonably big, having upon it a Village of 4 Houses called *Ottoek*; above this Town upon a little Eminence stands a Church, which is no small Ornament. Those that live on it have Fields, Meadows, Pastures, Wood, Gardens, and Orchards, and all things necessary for Life.

There is also a very fine *Peninsula* all covered with Wood, called *Dörvassek*. When the Lake is up, and one comes in a Boat between the Island *Vornek* and this

this *Peninsula*, the farther Part of the Lake, lying under the Mountain, very well resembles a curious Port for Shipping. At the farther End, when the Water draws off, there appear Rows of Stakes, a Sign that there hath been formerly a *Bridge*, and therefore it is at this Day called the *Old Bridge*.

In this Lake there are many Pits in the Shape of Basons or Cauldrons, which are not all of the same Depth or Breadth; the Breadth of them being from 20 to 60 Cubits more or less, and the Depth from 8 to 20 Cubits. In the Bottom of the Pits are several Holes, at which the Water and Fishes enter, when the Lake ebbs away.

The principal Pits in which they fish, are 18, situated and named as is Fig. 60. represented in the Map. They are called *Maljoberch*, *Velkjoberch*, *Kamine*, *Sueiuskajamma*, *Vodonos*, *Louretschka*, *Kraloudour*, *Rescheto*, *Ribesekajamma*, *Rethje*, *Sittarza*, *Lipanza*, *Gebno*, *Koteu*, *Ainz*, *Zesslenza*, *Pounigk*, and *Levishe*. Besides these, there are several other lesser Pits of no Note, because there is no such fishing in them as in those but now mentioned.

In the Months of *June*, *July* and *August*, when this Lake begins to draw off, it grows quite dry in 25 Days, if no great Rains intervene. And the aforesaid 18 Pits are all emptied the one after the other, in a certain and never failing Order of Time.

When the Lake begins to sink, which appears by a certain Stone, which they observe, the Inhabitants of the Town called *Oberdorff* or *Seedorf*, give notice thereof to all the neighbouring Fishermen, that are appointed by the several Lords having Right in this Fishing. The People of this Town have Orders not only to watch the falling away of the Water, but likewise to take care that no body presume to fish in the Lake when it is full of Water; that being forbidden: So that these are, as it were the Keepers of the Lake.

1. The first Pit called *Malijoberch*, is not properly a Pit like a Cauldron, but only a Depression of the Bottom without any Holes in it: But there grows much Grass and Weeds, and many Fish are catch'd therein: Three Days after the Water begins to ebb, this Pit is emptied: Then the Parish Clerk of *Seedorf* gives notice thereof by tolling a Bell, and all the Inhabitants of the Town, Old and Young, Men and Women, lay aside all other Business and go to fishing, stark naked as ever they were born, without any Regard to Modesty or Shame.

The Fish they catch they divide in halves, one Part they give to the Prince of *Eggenburg*, as the Lord of the *Mannour*, the other half is their own.

2. The Pit *Velkjoberch* is empty the 3^d Day after *Malijoberch*, the Manner and Right of fishing as in that.

3. Four Hours after this, the Pit *Kamine* begins to empty; here they generally fish with a Trawle, as in several other Pits of lesser Note, having first purchased Leave of the aforesaid Lord of the *Mannour*. Here, as likewise in the Pit

4. *Sueiuskajamma* (which sinks one Hour after *Kamine*) is much Fish caught, and Abundance of large *Crabs*; but they are lean, and of no good Taste.

5. The fifth Pit *Vodonos* dries 5 Days after *Kamine*. In this and the other Pits which follow they fish with a long Net or Sayne. Herein they can have

no more than five or six Hawls, by reason of the great Swiftneſs wherewith the Water runs away at the Holes in the Bottom, (which is ſuch that a Horſe can hardly keep pace with it) and carries away the Fiſh with great Violence under the Earth. Sometimes when Fiſhermen are not nimble, they can ſcarce get two Hawls before the Water be gone; to prevent which they have a Mark near this Pit, viz. the *Stone Ribeskekamen*, that is the *Fiſher's-Stone*, which as ſoon as it begins to appear upon the Recess of the Water, gives notice that it's time to begin the Fiſhing.

6. The Pit *Louretſchka* is evacuated a Day and a half after *Vodonos*, the Fiſhing is after the ſame Manner, and the ſame Caution neceſſary, becauſe of the ſudden Recess of the Water.

7. The Water leaves the Pit *Kraloudour* 12 Hours after *Louretſchka*; and 3 Days after that

8. The Pit *Reſcheto*. In this latter, in the Year 1685, after the Lake had been ſome Years without being dry, there were taken at the firſt Haul, 21 Carts of Fiſh, at the 2^d 17; and at the 3^d 9, as I have been credibly informed by thoſe that were preſent

9. The Pit *Ribeskakamma* falls dry at the ſame time with *Reſcheto*, which is that next to it. In this Pit they fiſh under Ground, which is a Curioſity not unpleaſant, and differing from all the reſt. For there is in the Bottom a great Hole in the *Stone*, by which Men may eaſily go down with lighted Torches, as into a deep Cifterne; and there is under a large Cavern like a Vault, the Bottom or Pavement whereof is as it were a Sieve full of little Holes, whereby the *Water* runs away leaving the *Fiſh* dry, where they are caught.

10. The Pit *Rethje* is empty two Hours after *Ribeskakamma*, and is of no great Conſequence for Fiſh: An Hour after this, the Pit 11. *Sittarza*, and in 5 or 6 Hours more 12. *Lipanza* falls dry.

13. The 3^d Day after *Reſcheto* the Pit *Gebno* is evacuated; in this they rarely fiſh with Nets, but let fall dry; and the Holes in the Bottom being ſo ſmall, that they exceed not the Size of a Man's Arm, all the great Fiſh are left behind in the Pit.

14. Two Days after *Gebno* the Pit *Koteu* becomes dry: In this they ſometimes take the Fiſh as in the former, but the Holes being greater let bigger Fiſhes paſs.

15. The Pit *Ainz* empties 4 or 5 Hours after *Koteu*: in this they ſeldom (unleſs they cannot help it) let the Water run away without uſing their Nets, as in *Gebno*; becauſe of one great Hole in the Bottom whereby many great Fiſhes may eſcape.

16. The Pit *Zeflenza* ſinks three Hours after *Ainz*; in this they always fiſh with Nets. As in

17. *Pounigk*, which is emptied the next Day after *Koteu*:

18. The laſt Pit called *Leviſche* is evacuated the third Day after *Pounigk*, that is the 25th Day from the beginning of the Recess of the Water of the Lake, ſo that in 25 Days the fiſhing of this Lake is over. In this laſt Pit about 17 Years ſince, I am certainly informed, that there fell a Flaſh of *Lightning* about the time of *Fiſhing*, which ſtunned a great Multitude of large
Fiſhes.

Fishes, so as that they filled 28 *Carts* with them: (By a *Cart* is meant as much as one *Horse* can draw.) These *Fish* are not properly *Thunderstruck*, but only stunned with the Violence and Sulfureous Vapour of the *Lightning*, which makes them rise and swim as dead upon the *Top* of the *Water*; but if they be taken up and put in fresh *Water*, they soon recover, otherwise they die. This is no uncommon Accident in this *Lake*.

The *Fishing* being thus ended, a *Sign* is given by tolling the *Bell* in the *Chapel* of *St. John Baptist*, near the *Town* of *Cirknitz*: Upon which all the *Inhabitants* of the *Neighbouring Villages*, and of *Cirknitz*, without *Regard* either to *Age* or *Sex*, go for the most part stark naked into the *Lake*, and look for *Fish* among the *Weeds* and *Sedge*, and in the smaller *Pits*. And many creep into the *Subterraneous Caverns* and *Passages*, and find *Store* of large *Fishes* there: They having full *Liberty* to search all over the *Lake*, excepting in the *Pits* *Pianze*, *Narte*, and *Velkjoberch*. This *Barbarous* and *Immodest Custom* of going *Naked*, has been often attempted to be reclaimed by the *Carthusian Monks*, but all in vain; for so prevalent is a *Habit* of vicious *Practices* over good *Precepts*, that they have not yet been able to persuade them so much as to cover their *Secrets*.

There are besides these some other *Pits* in the *Lake*, as *Skednenza*, *Mala* and *Velkabobnarza*, in which they fish likewise, as also in *Mala-karlouza* and *Velka-karlouza*: In both these they go far under *Ground* with lighted *Torches*, and find *Fish*, but these *Pits* are of no great *Value*. In *Velkabobnarza* one may go in at great *Holes*, and descend many *Fathoms* under *Ground*. These two Names *Velka* and *Mala-bobnarza*, signify in the *Carniolan Tongue* the greater and lesser *Drummer*; nor is it without *Reason* that these *Pits* are so called; for when it *Thunders* and *Lightens*, there is heard in these two *Pits*, as it were, the *Sound* of many *Drums* beating, which *Anno* 1685 I heard with my own *Ears*; it *Thundring* 3 times successively, and the *Sound* of *Drums* answering accordingly.

The two *Pits* *Narte* and *Pianze* are never emptied, but always remain *Fenny*, when the rest of the *Lake* is quite dry. It is believed that in these *Pits* the *Fish* lay their *Spawn*, and therefore it is prohibited to fish in them. In them is an incredible *Number* of *Horse-leeches*, which, according to the vulgar *Opinion*, understand certain *Words*; for that upon repeating them, they will come in great *Parties* towards him that repeats them; whereas if he be silent, very few of them will touch him. These *Horse-leeches* often stick upon the *People* in the *Fishing Time*, (some of them being dispersed all over the *Lake*) and the *Method* they take to get them off, is to get some other *Person* to piss upon the *Leech*, which makes it let go its hold; and this, without any *Respect* to *Modesty*, is practised as well upon the *Women* as *Men*.

There are in the *Mountain* nigh the *Lake*, but something higher than it, two great and terrible stony *Caves*, the one called *Urainajamma*, the other *Sekadulze*, which tho' far distant one from the other, have yet the same *Effect*, viz. When it *Thunders* and *Lightens*, these two *Caves* do emit *Water* with a wonderful and incredible *Force*, and with it sometimes a great *Quantity* of *Ducks*, with some *Fish*, which I my self observed in *October* 1685, not with-

out

out great Danger of my Life. I took my Horse and rid cross the Lake as far as the Island *Vornek*, in Company with two old experienc'd *Fisbermen*; when suddenly the *Cavern* in the Mountain *Silvenza* began to breath forth misty Vapours, forming a Cloud. Upon which my *Fisbermen* advised me to make Haste, for without doubt those Clouds would produce a *Tempest*. They had scarce said so, when it began to lighten and thunder dreadfully; and I had Difficulty to persuade them to accompany me as far as the Pit *Velkabobnarza*, being desirous to examine what is said of it, that when it thunders, the Sound of many *Drummers* is heard in it. This I found 3 times to succeed as reported, and then with all the Speed we could, we hasted to the Island *Velkagoriza*, not being able to go farther, because the Water was in many Places grown out of our Depth, where two Hours before we had passed dry. Here we got one of the little *Fisher-boats*, which when the *Lake* is dry, lye disperfed here and there on the Bottom; and having got in my Horse, we began our Voyage, but had the ill Luck to overset our Boat, and so were oblig'd to swim for't, and with much to do arriv'd safe on the other *Shore*. Then we could see from the other Side, that the Water gushed with great *Impetus* out of the Cave *Sekadulze*, being cast 3 or 4 Fathom, as if it were forced by a *Fire-Engine*, and several blind *Ducks* were thrown out by the *Water*. It is not to be wondred that the *Lake* fills so fast, for considering the Violence where-with the *Water* rushes, it is as much as a great *River*; this Cave *Sekadulze*, being a Fathom wide, and higher than a Man. It is look'd upon as a dangerous Thing to enter into this Cave, because the *Water* comes so all on a sudden, that if it should chance to come it is impossible to escape it.

When it rains moderately, the *Water* spouts with great Violence Two or Three Fathoms perpendicularly, out of the Pits *Koten* and *Zeslenza*. It comes likewise forcibly out of the Spring *Tresenz*, as likewise out of *Velkiobersch*, bringing with it, at this latter, abundance of *Fish*, and some *Ducks*. But when it rains very hard and long together, especially with *Thunder*, then the *Water* breaks out with very great Force, not only from all the aforesaid Pits, *Holes* and *Caves*, but likewise at several thousand other little *Holes*, which are all over the Bottom of the *Lake*, and which, when the *Lake* is dry, drink up the *Waters* of the 8 *Rivulets* that run into it, spirting several Fathoms high, from some perpendicularly, from others obliquely, so that there is not a pleasanter Sight than this. And out of the Pits *Vodonos*, *Rescheto*, and some others, having great *Holes* at the Bottom, there comes with the *Water* a great Quantity of *Fish*. In case of great Rains, the 8 *Rivulets* are likewise much increased, so that all things concurring, this *Lake* in 24 Hours Time, will, from quite dry, be full of *Water*, and sometimes in 18 Hours; tho' at other times, it has been known to be 3 Weeks in filling. But it is a constant Observation, that *Thunder* and *Lightning* help much to fill it speedily.

This *Lake* being thus by Turns wet and dry, serves the Inhabitants for many Purposes. For 1st, while it is full of *Water*, it draws to it several Sorts of *Wild-geese*, and *Ducks*, and other *Water-Fowl*, as *Hérons*, *Swans*, and the like, which may be shot, and are very good Meat.

Next, as soon as the Lake is emptied, they pluck up the *Rushes* and *Weeds*, which make excellent *Litter* for *Cattle*. 3. Twenty Days after it is fully dry, they do cut a great Quantity of *Hay* upon it. 4. After the *Hay* is in, they plow it and sow *Millet*, which sometimes, by the too sudden coming of the *Water*, is destroy'd: But it generally comes to Maturity. 5. While the *Millet* is on the Ground, they catch a great Number of *Quails*. 6. The *Millet* being in, there is good Pasture for *Cattle*. 7. When the Lake is dry, there is great Variety of Hunting; there coming out of neighbouring *Woods*, and *Mountains*, Plenty of *Hares*, *Foxes*, *Deer*, *Swine*, *Bears*, &c. so soon as the *Water* is gone. 8. When it is full one may fish in it. 9. In *Winter-time*, it will be so firmly frozen, as to bear all Sorts of Carriages, and is a great Convenience to the People to fetch their Wood and other Necessaries. Lastly, At the Time when the *Water* goes away, it yields great Abundance of Fish, as hath been already said. And that which is most wonderful, is, that all this comes to pass in the same Place, and the same Year, viz. If the Lake be early dry, and it fill not too soon; but it is to be noted, that the *Hay* does not grow, nor is the *Millet* soon all over the Lake, but only in the more fertile Places.

There are only these Sorts of Fish taken in this Lake, which are very well tasted. They are the *Mustela fluviatilis*, or *Eel-pout*, some of them weighing 2 or 3 Pounds; 2. *Tench*, some of them weighing six or seven Pounds. And 3^{dly}, *Pikes* in very great Plenty, of 10, 20, 30, and some of 40 Pound weight; in the Bellies of these it is common to find whole *Ducks*; *Crabs* are found no where but in the *Pits*, *Kamine*, and *Suejuskajamma*: They are large, but ill tasted.

The Cause or rather *Modus* of all these wonderful *Phænomena* in the Lake of *Zirknitz* is, according to my Opinion and Speculations, as followeth; there is under the Bottom of the Lake, another subterraneous one, with which it communicates by the several Holes described. There are also one or more Lakes under the Mountain *Javornick*, but whose Surface is higher than that of the Lake of *Zirknitz*. This upper Lake is possibly fed by some of those many Rivers, which in this Country bury themselves under Ground, and has a Passage sufficient to carry the Waters they ordinarily bring into it: But when it rains, especially in *Thunder-showers*, which are the most hasty, the Water is precipitated with great Violence down the steep Valleys, in which are the Channels of these *Rivulets*, so that the Water in this Lake being increased by the sudden coming of the Rains faster than it can empty, swells presently, and finding several Holes or Caverns in the Mountain higher than its ordinary Surface, it runs over by them both into the subterraneous Lake, under that of *Cirknitz*, into which the Water comes up by the several Holes or Pits in the Bottom thereof, as likewise, by visible Passages above Ground, such as *Urainajamma*, *Secadulze*, and *Tresenz*.

That some of these Passages bring Fish, some Ducks and Fish, others only Water, seems to depend on the Position of the inward Mouths of these subterraneous Channels; for if they be so constituted, as to draw off the Water from the Surface of the upper Lake on which the Ducks swim, they must needs

be drawn away by the Stream into these *Caverns*, and come out with the *Water*: But if so, that the *Channels* open into the upper *Lake*, under the Surface of the *Water*, and from thence ascend obliquely, for some Space before they come to descend, then the *Water* they carry is drawn from below the Surface, and consequently can bring with it no *Ducks*, but only *Fish*. Those *Pits* which yield only *Water*, may well be supposed to be fed by Passages too narrow to let the *Fish* pass, tho' their Multitude may make the Quantity of *Water* they emit to be very considerable.

The Manner of the *falling away* of the *Water* or *emptying* of the *Lake*, I thus explain. After a long Drought or Want of *Rain*, all the Springs that feed the upper *Lake* under *Javornik* are much diminished; so that wanting fresh Supplies, it ceases to run over by the several Channels but now mentioned: Hence the *Lake* of *Zirknitz*, and that under it, are fed only by the 8 Rivulets that always fall into them, and then the *Water* draws off faster than it comes in, both by the Channels of *Mala* and *Velka-karlouza*, as also by a concealed subterraneous Passage out of the under *Lake*, which latter alone is able to transmit more *Water* than the said 8 Rivulets afford. Consequently the *Lake* must sink, and that in a certain Proportion of Time, depending on the Quantity of *Water* to be evacuated, compared with the Excess of that that runs out, above that that enters at the same Time. 1. Those *Pits* that are higher are soonest dry, the lower latest, and so come to be emptied in the Order above described; and when the *Lake* is all dry, then the said Rivulets soak by several little Holes in the *Bottom*, into the under *Lake*, and all their *Water* is carried away by the afore said subterraneous Passage.

That there is such a Passage is very evident, and that it communicates under Ground with the Channels of *Mala* and *Velka-Karlouza*, coming out with them, as hath been already said, near *St. Cantian* at a Rocky Cave, and making the River *Jesero*: For when the *Lake* of *Zirknitz* is very full, and runs out of both *Velka* and *Mala-Karlouza*, the River *Jesero* at *St. Cantian* overflows, and runs with great Violence; when it only runs out at *Mala-Karlouza* (which is somewhat lower than the other) then the *Water* of *Jesero* is much less rapid; but when the *Lake* is so fallen, that it runs out at neither of the two, the River *Jesero* is still less, but runs with a considerable Stream, till 2 Days after the *Lake* has been dry; after which, the said River becomes little, voiding no more *Water* than the *Lake* receives from the 8 Rivers that run into it: By which it is clearly proved, that this subterraneous Passage does meet with the Channels of *Velka* and *Mala-Karlouza*, and needs no farther Illustration.

Hence it appears, why this *Lake* sometimes is twice or thrice dry in a Year, at other times continues full for 3 or 4 Years together, but was never known to be dry for a whole Year's Time; for it falls dry at any Time, when there falls but little *Rain* in a long Space of Time, and in rainy Years it continues always full; but it never happens in this Country, that there is a Drought for a whole Year together.

The *Ducks* I have so often mention'd, and which are cast out with the *Water*, are generated in the *Lake* under the Mountain *Javornik*; when they first come out they swim well, but are stark blind, and have no *Feathers* on them, or but few, and therefore are easily caught; but in 14 Days Time they get *Feathers*, and recover their Sight yet sooner, and afterwards fly away in Flocks. They are black, only white on the Forehead, their Bodies not big, resembling ordinary *Wild-ducks*, and are of a good Taste, but too fat, having near as much Fat as Lean.

I kill'd some of them, as soon as they had been cast out at *Sekadulze*, and opening their Bodies, I found in them much *Sand*, and in some few, small Fishes, in others green Stuff like Grass or Herbs, which was the more strange, because I never found any green Thing growing in any of our *subterraneous Grottoes* or *Lakes* in *Carniola*; I tried also to procure some of the Fish at the Time of their being cast out, to open them, and see what they live upon, but notwithstanding all my Endeavour, I could not get any of them to satisfy my Curiosity withal.

Almost every Year, at a Hole in the Mountain called *Storseg*, about half a German Mile from the Lake of *Zirknitz*, near the Town of *Laas*, whenever there happen great Floods of Rain, this sort of *Ducks* is cast out in great Abundance, by the Water gushing out with much Force. I conceive that this *Cavern Storseg* is another Passage out of the same Lake under *Javornik*, that overflows and fills up our Lake of *Zirknitz*; but this being somewhat higher, it never runs out, unless the said Lake be more than ordinary swelled by the Violence of the Rains. The casting out of great Numbers of *Ducks* here, is so common, that it is look'd upon as no Rarity.

It may seem strange and hard to believe, that there should be such *subterraneous Lakes* and *Channels* as we may suppose; but besides that, without them it would be impossible to account for all these several Effects, which are most true, and which I my self have observed: There is a most notable Instance of the like Things found in the *subterraneous Cavern* called the *Grotto Podpetschio*.

Fig. 3: This *Grotto* is in *Carniola* in the Parish of *Guetenfeld*, distant four German Miles from the City *Labac*. *a*, is a Hole or Entrance into the rocky Mountain; *b*, is a great *Cavern* in the Mountain, capable to hold above a hundred Horsemen; *i*, *k*, is a Channel big enough for a Man to pass by, as far as the Lake *o*, out of which Lake the Inhabitants hereabouts draw all their Water, having none nearer, and fetch it with lighted Torches. Into this Lake *o*, the Water runs with a great Stream by the Channel *l*, and out of this Lake it falls down a Precipice into a great Cavern, with so much Noise, that the Discharge of a Pistol would not be heard here. There is likewise another Channel *m*, which tends upwards obliquely, and leads to the great Lake *n*, whose Length and Breadth are hitherto undiscovered; I look'd about it with many Lights, and could see nothing but Water, and throwing Stones several Ways as far as I could, I heard them all fall in the Water: And I found the Depth of it near the Bank to be Ten Cubits, and doubt not, but it is much deeper in the Middle.

The

The Country People told me, that this Channel *l*, affords always an equal Quantity of Water, or else is quite dry; and that sometimes it will cease to run in a Moment, and continue dry for some Weeks, and then on a sudden it will run again with great Force, so as the Noise thereof frequently frights the People as they come for Water.

Out of the Cave *b*, there is another Channel *c*, which is divided into three others *d*, *e*, *f*. This Channel *f*, tends obliquely downwards, till it comes to a running Water in *g*, from whence one may go on to *b*, where looking thro' a little Hole, one may see another little Lake.

All the Channels I have mentioned, are formed in a very hard Rock, and are smooth or polished, as if cut by Men's Hands. These may be seen by any one that will go with lighted Torches; and there are many such in which I have not been.

If any one would carry a Boat to the Lake *n*, and would row upon it, I doubt not but he might find several curious Things. I believe this *subterraneous Lake* to be a German Mile long: For from this *Grotto Podpetschio*, at a Mile's Distance, there is a Village called *Kompale*, whose Inhabitants have no other Water, than what they fetch out of a Hole in the Rock, going with lighted Torches, by a large Channel, to a great Lake under Ground. I measured with good Geometrical Instruments, such as Miners use, the Level of these two Lakes of *Podpetschio* and *Kompale*, and found them to be in one *Horizon*; and this I did twice, both when the Channel *l*, at *Podpetschio* run, and when it did not run. When it began to run, I found, that the Lake *n* was two Cubits higher than it had been before, when it ceased to run, I came again on purpose to observe it, and found that then also, the other Lake at *Kompale* was in the same Level; from whence it is most certain, that these two, are only one continued *subterranean Lake*.

XX. The Lake of *Geneva*, which is one of the most pleasant Places of the World, lies like a *Croissant* of Water, one Extremity whereof is 18 Leagues distant from the other, and the Banks of which are gently rais'd to some Heights, then to Collines, at length to stupendious Mountains; which yet are not so linked to one another, but that they leave betwixt them Interstices of 15 or 20 Leagues Prospects, checkered by Meadows, Corn-fields, Orchards, Vines, Forests of Fir-trees, Snow lying on the Sides of the Rocks. All those Objects, which at a Distance are confounded, and seem to make but one, have near hand their several Beauties. That Point where *Geneva* stands, is somewhat longer and more extended than the other. This *Croissant*, where 'tis largest, which is from *Morges* to *Thonon*, is about 5 good Leagues over.

The Water of this Lake is very good to drink, and even so limpid, that even in the rolling of the Waves, which sometimes go high enough, the Water is not troubled but along the Banks. And if one do attentively look down from the Castle of *Chilon*, or from any of the neighbouring Heights, into the Bottom of the Lake, he may see high Mountains under the Water. And the Water is so deep, before *Vevray*, that the sounding Line at the End of 400 *Fathoms*, seems, because it will not stay, to touch upon something slippery.

Slippery. 'Tis held to be 500 *Fathoms* deep before *Roole*; and 'tis affirm'd, that near this great Depth there may be seen a kind of Isle under Water.

The *Rhone* enters at one of the Points of the *Croissant* into the Lake, and issues out at the other; but with this Difference, that whereas he comes in dirty and miry, he ever goes out so pure and clear, that under the Bridge of *Geneva*, where the Water is deep 25 Feet in Summer, you may well discern the smallest Stones at the Bottom. And the same Water, which in this Place appears of a *Sapphyrine Blew* in the Shade of the Houses, appears altogether *Green*, nor is so transparent, when the Sun shines on it.

Having heard the Sentiments of the Curious of *Lausanne* and *Geneva*, and the Opinions of the most knowing Fishermen, that are there in great Number, and especially at *Coupet*, I believe with the latter, that although the *Rhone* entering into the Lake loseth its Violence; yet doth he still keep some sensible Motion in some Places, and every where observable, and that no *Trouts* are taken any where in this Lake but in this *Curent* of the *Rhone*.

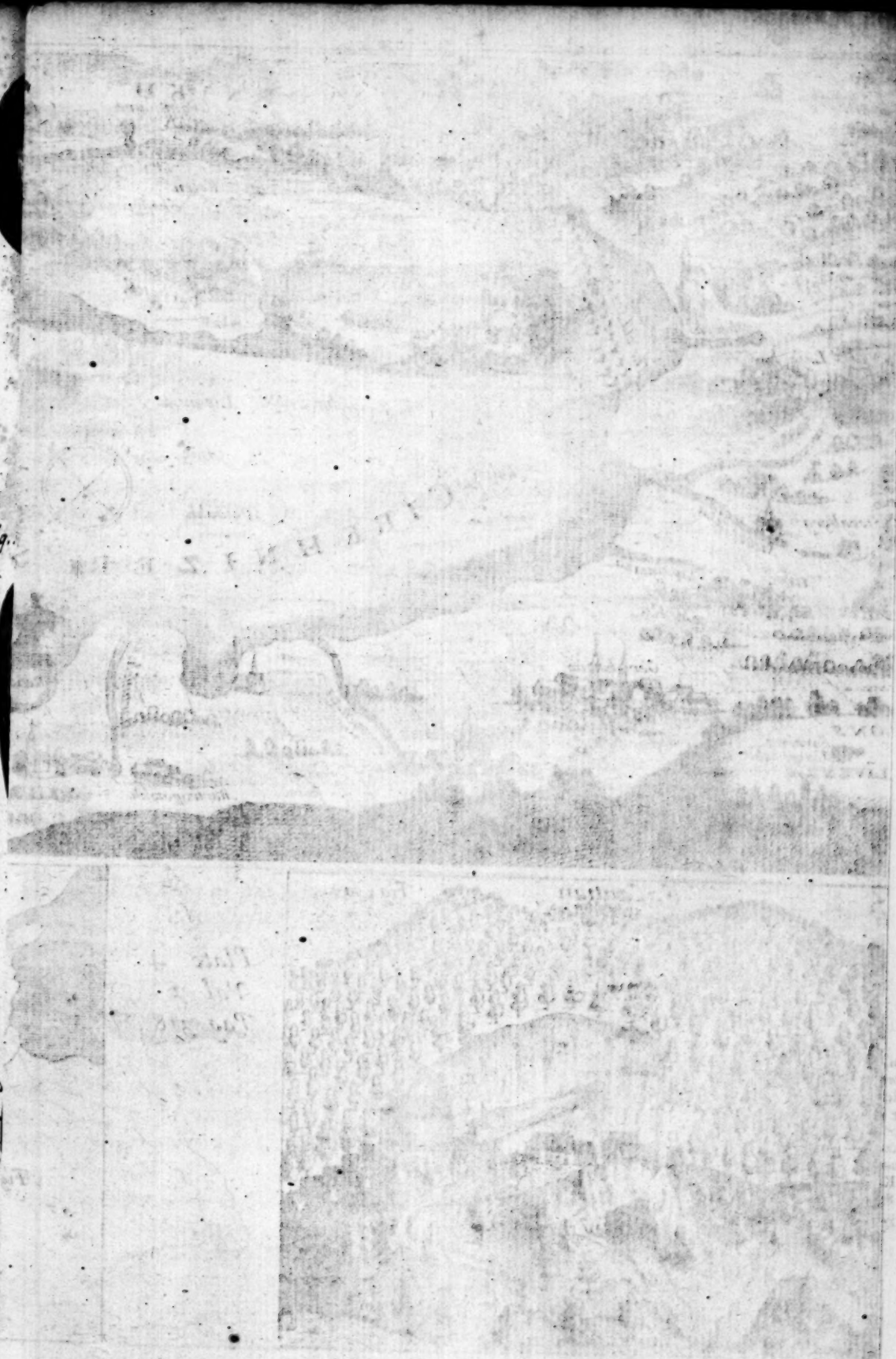
The Water of this Lake commonly begins to encrease about the End of *January*, or the Beginning of *February*, and continues to do so unto the 20th of *July*, and often unto the very Month of *August*; and then it insensibly decreaseth, so that the Water is less high in Winter than Summer, by 12 or 15 Feet. About this Increase of the Water there are different Opinions; 'Tis true, they all believe in general, that the principal Cause of the Increase of the Water is the melting of the Snow, and of the Mountainous Ice, that is in the Winter formed of the Waters of the Springs, and Torrents, which the Frost fixeth. This is so true, that when there is much Snow in Winter, the Waters are very high the ensuing Summer: But when great Rains chance to fall in *January*, then the Snow, not yet being well hardned, melteth on a sudden altogether; And when this Melting is not so violent, all the Snow, that will melt, melts at the End of *May*, or the Beginning of *June*, so that, there remaining but the Stock of Ice for entertaining the Increase of the Water unto the Month of *August*, some have thence been induced to assign other Causes.

At the Issuing out of the Bars, that from *Geneva* on the side of the Lake, are seen in the Water two or three huge Flints standing out of the Water, the chief of which they call *Niton*: And the Tradition is, that it formerly was an Altar consecrated to *Neptune*, there being also a Place cut out in the Middle, which they take to have been the Place for the Sacrifice. On this Flint 7 or 8 Persons can sit; and sometimes, when the Waters are very low, there are found about it Knives, and Needles, as thick as Bodkins of Tweezers, and much longer; both of Brass, well enough made, and esteemed for to have served for the Sacrifices.

This Lake in serene and calm Weather appears sometimes, and that even before Sun rising, as if it were made of diverse Pieces differently coloured; part of it being browner than the rest; which seems to be caused by a Breath of Wind passing thorow the Water, coming either from the Bottom of the Lake or from above; though others think this gentle Agitation

Fig.

Geological
Department of the
Interior



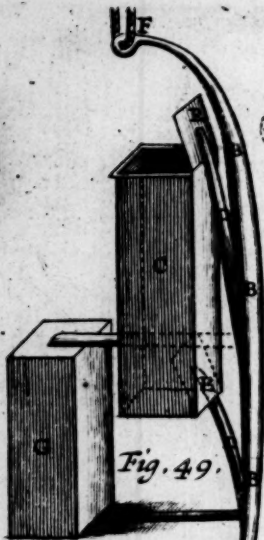


Fig. 47.

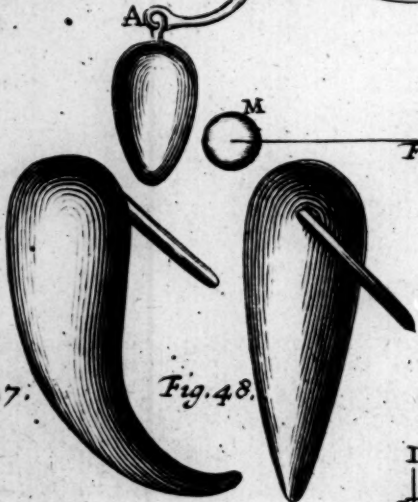


Fig. 48.

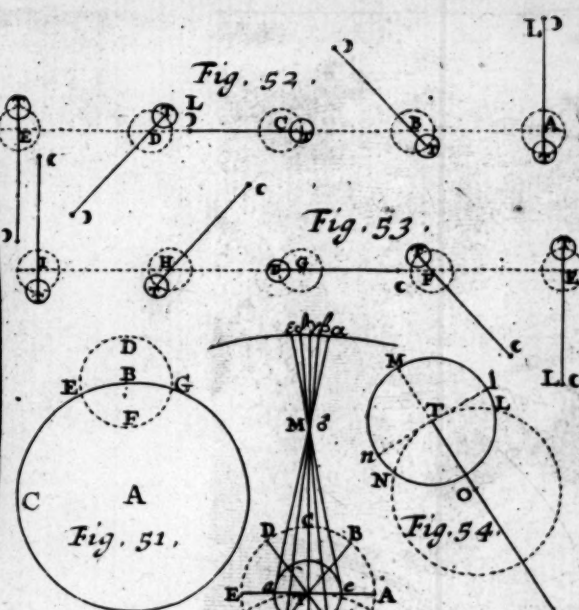


Fig. 51.

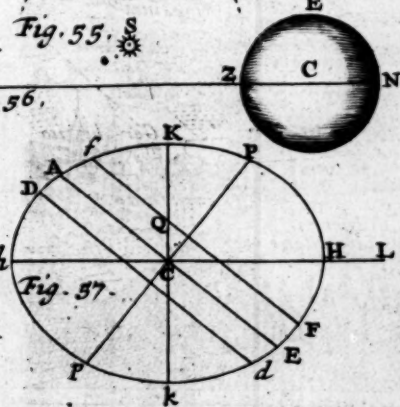


Fig. 56.

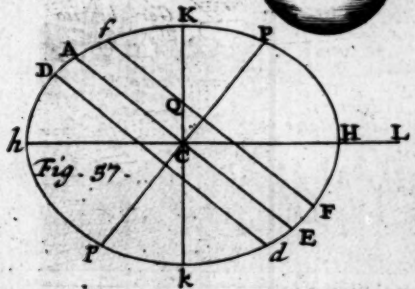


Fig. 57.

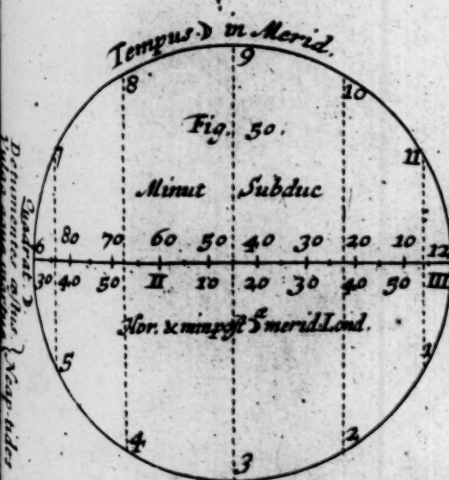


Fig. 30.

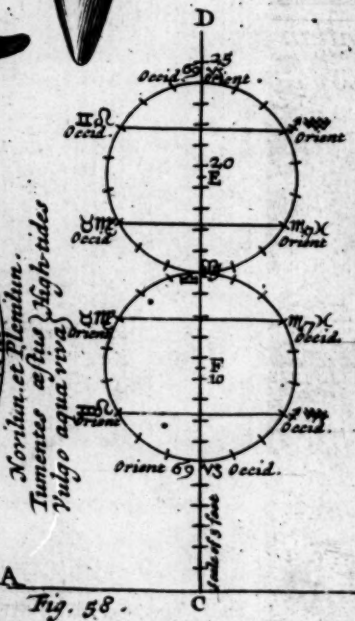


Fig. 58.



Fig. 59.



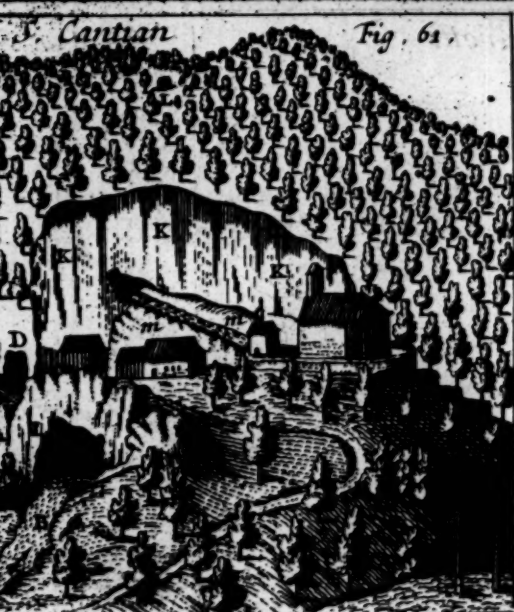
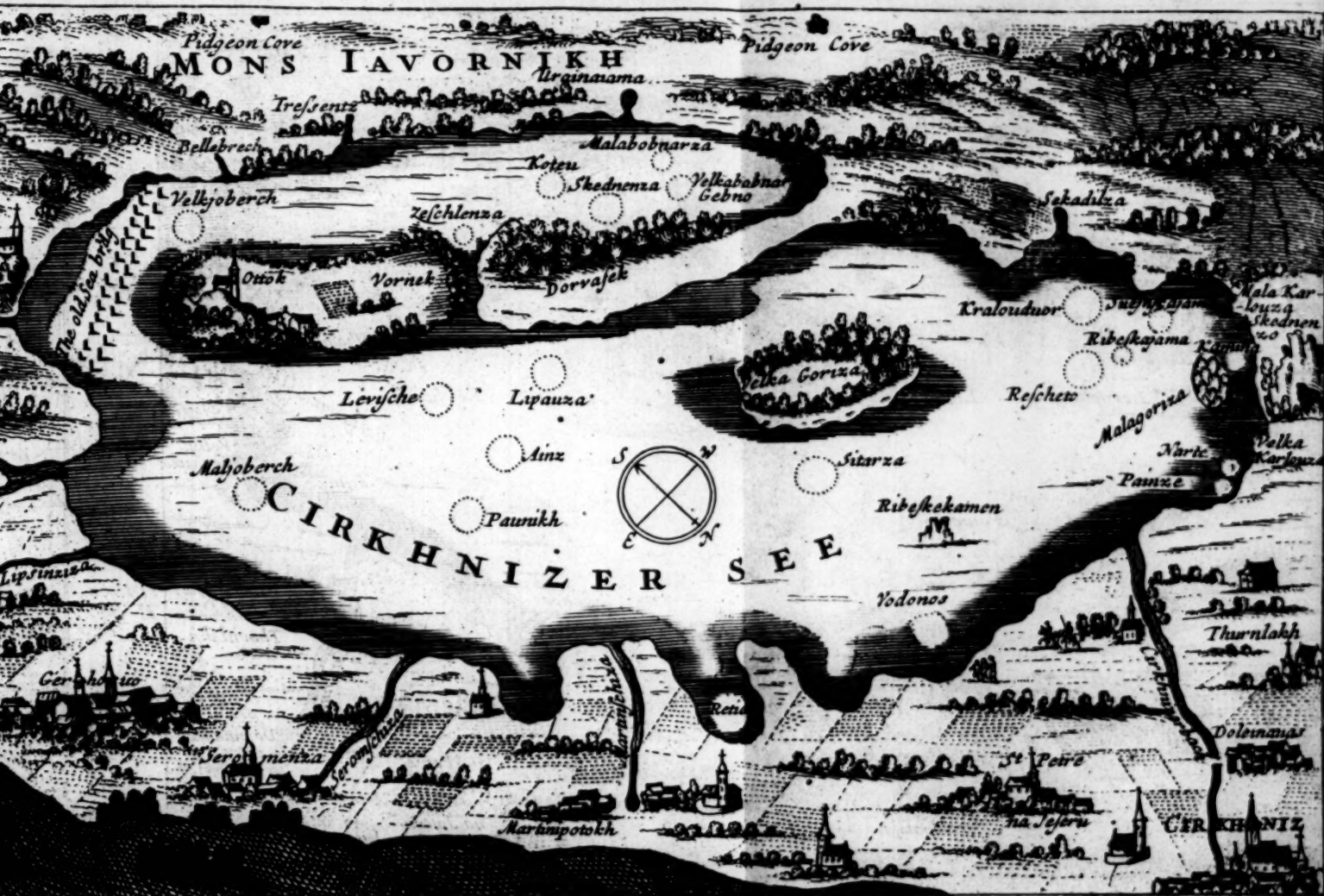


Plate 4.
Vol. 2.
Pag. 318.

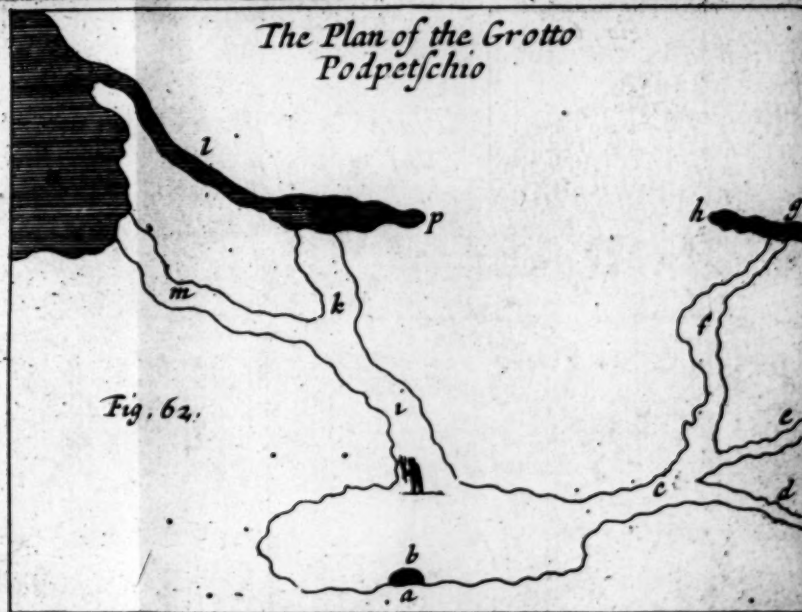
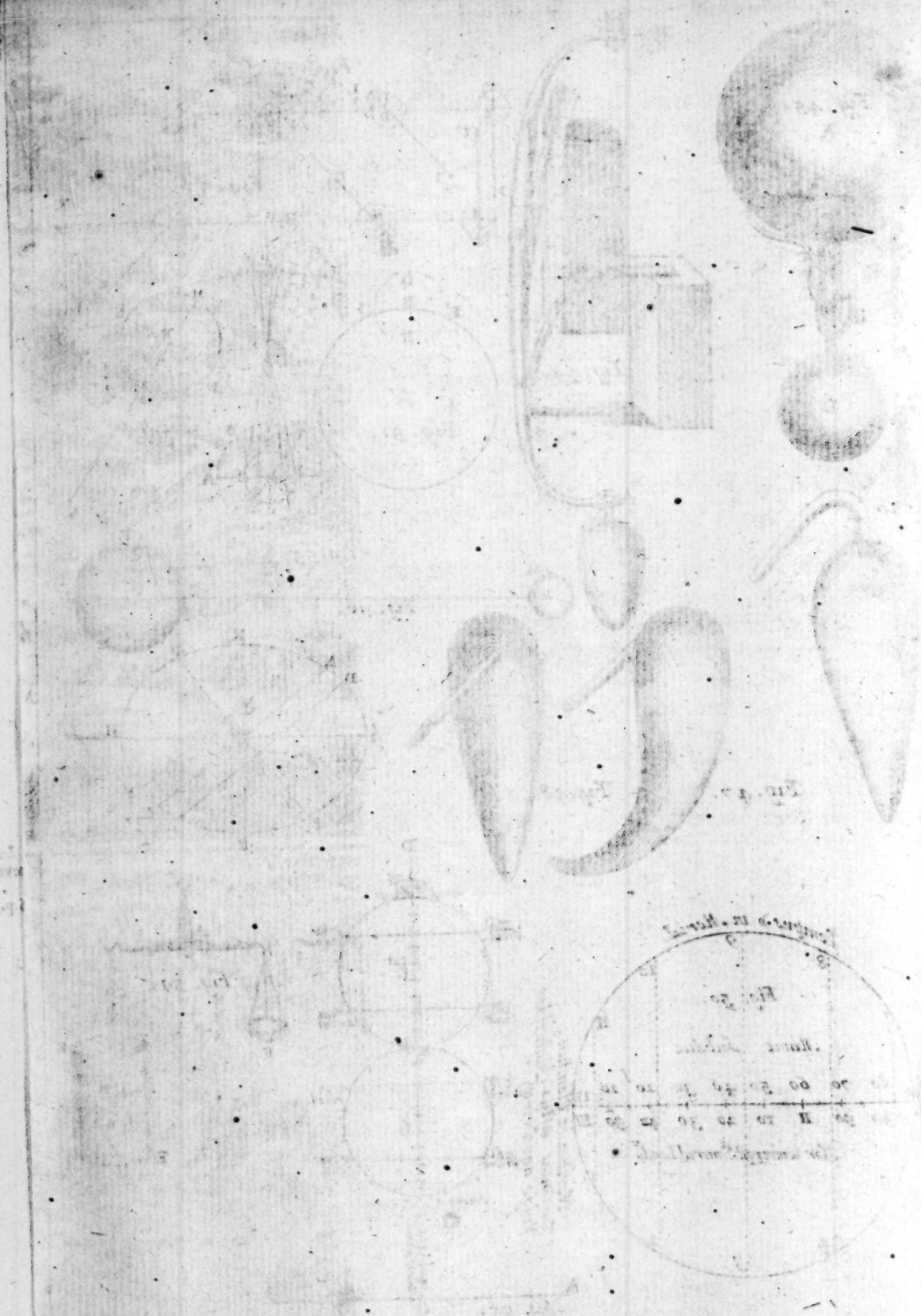


Fig. 1.
Fig. 2.



tation to proceed from some Springs that are at the Bottom, making the Water shiver above. But that Part of the Water, that is not moved, appears as even and smooth as a Looking-Glass, or like Water traced by a Ship. And as for the Colours, they are, in my Opinion, an Effect of the neighbouring Mountains, the different Images of which, being confounded in the Water, make an Appearance of very pale Colours.

After that the *Rhone* is entered into the Lake, he retakes not his impetuous Course before a Quarter of a Mile's Distance from its coming forth again, that is, above *Geneva*. And the nearer he comes to that Town, the more his Bed becomes narrow, and consequently his Course more rapid. Yet this Rapidness hath been in our times once surmounted by Wind, and once by Water.

In the Winter of the Year 1645. there arose in the Morning, about 9 a Clock, so furious a Wind, that not only it uncovered the House, but also laid dry the Bed of the *Rhone* above the Bridge, so that many, in the View of all the Town, crossed quite over it (to the little Island) dry Foot, and one of the Sons of M. *D'Aubigny* took up some Medals, which he found in his way. This Passage was free during an Hour's time, at the End of which the River retook its Course. At that Season the Water being very low, and a West Wind, to arrive at *Geneva*, being pressed by the high Mountains, that bring it upon the Town as by the Nose of a Pair of Bellows, it came to pass, that the Wind did violently bear upon the Water near the Bars, keeping suspended the Water that was beyond, and those Waters that were beneath running away downwards by a Declivity, and under the Shelter of the Houses. Whilst I was scrupling at this Relation, they brought me *Gallastus* his Commentary upon *Exodus*, Printed 1560; where 'tis recorded, that the like Accident had fallen out at *Geneva*, at the Time when that Minister lived there, a South-west Wind having made the *Rhone* to recoil into the Lake, and many People having thereupon passed over dry for an Hour's time.

Concerning the other Accident; you may remember that the River *Arve*, which is a kind of Torrent, falls into the *Rhone*, about 1000 Paces beneath *Geneva*. In the Month of *December*, in the Year 1652, the said *Arve* did so extraordinarily swell, that not only it over-run its Banks with Imperiety, but also interrupted the Course of the *Rhone*, and forced it to re-enter into the Lake for the Space of 14 Hours.

This Lake doth very much abound with Fish, which have, as it were, cantoniz'd themselves, and divided the Lake amongst them. The *Trouts* are not to be found there, but, as hath been already mentioned, in the Current of the *Rhone*; the *Carps* have taken up their Quarters towards *Vevay*; the *Pikes* and *Pearches* have also their Habitations a-part: But some other Fish, that are but Passengers, not living constantly in the Lake, spread themselves almost every where indifferently. The great *Trouts* pass out of the Lake for 4 Months of the Summer, and are taken in Autumn when they are returning thither. The Fishing is farmed out at *Geneva*; and there are Conservatories, where many of these big *Trouts* are kept, among
which

which there are some that weigh Fifty Pounds. Sometimes they catch *Pikes* there of 80 Pounds Weight; and a Pound Weight at *Geneva* you know to be 18 Ounces.

In the Months of *July* and *August* they fish for the Fry of *Pearches*, at a Time when they are no bigger than the smallest Taggs. These are a very delicious Dish, there called *Mille Cantons*.

The Lake A-
vernus; By
Dr. Tancred
Robinson, n.
172. p. 1038.

XXI. I have seen many Water-Fowl feeding upon and flying over the *Lake Avernus*, reported by many of our own, as well as foreign Writers, to kill Birds at a Distance. I observed several Land Fowl also to fly over that Lake, without the least Disturbance, from all Sides, and Ends. But peradventure the poysonous Steams (if there are any peculiar to that Lake) sometimes vanish, and return again; or else may be alter'd by new *Effluviiums* intermingled with them.

The Lake of
Mexico; By
..... n.
130. p. 758.

XXII. The Lake of *Mexico* hath this of extraordinary, and perhaps peculiar, that Part of its Water is sweet, and the other Part salt; which make it believed to be derived from two Sources, whereof the one holds sweet Water, the other comes from some Mineral and *Saline* Earth found in the Hills through which this *Water* passeth, and is impregnated with the Salt which is dissolved in its Course: Or if it have no peculiar Source, it must be, that that which makes Part of the Lake salt, is the *Bottom* of the *Earth* under the *Water*, being in that Place full of Salt; which is confirmed by Experience, much Salt being made of it every Day, of which that City drives a great Trade with remote Parts, even the *Philippines* themselves, whither it is transported in considerable Quantities. That Part of the Lake which is sweet, is still and quiet; the salt Part is agitated and moved according as the Winds blow. The sweet Water is very good and wholesome, breeding Plenty of little Fishes; that, which is moved, is bitter Salt, breeding no Fish at all. The sweet Water is higher than the other and falls into it. The Water of the salt Part is 7 Leagues long, and as many Leagues broad, and hath above 22 Leagues in Compass; that of the sweet Water is near as big; and the whole Lake contains about 50 Leagues in Compass.

An Inland
Sea near
Dantzick,
yielding in
Summer a
poisonous
Substance;
By Mr. Kirk-
by, n. 83.
p. 4069.

XXIII. Near a small Village call'd *Tuckum*, $2\frac{1}{2}$ German Miles distant from *Dantzick* Westward, there is an *Inland-Sea* (made by the meeting of 3 Rivulets, some Springs from the adjoining Hillocks, and the descending Rain and Snow-water) of about half a German Mile long, and an eighth Part of such a Mile broad. The Soil of the Ground round about seems to be Sand mixt with Clay. Its Shore generally sandy, as is its *Bottom* also; its Depth, where deepest, four Fathoms; but for the most Part but one, or one Fathom and a half. 'Tis stored with wholesome and delicate Fish, as *Pearch*, *Roach*, *Eels*, &c. and famed for a small Fish much esteemed here, and not much unlike a *Pearch*, only not so party coloured, and having a larger Head proportionable to its Body called the *Cole-perch*. The Water sweet and wholesome; but only in the three Summer Months, *June*, *July*, and *August*,

August, it becomes every Year, during the dry Weather, Green in the Middle with an *hairy Efflorescence*; which *green Substance*, being by some violent Wind forced ashore, and with the Water drunk by any Cattle, Dog, or Poultry, causeth certain and sudden Death; whereas at the same Time, that a knowing and ingenious Person (who first acquainted me with it,) saw three Dogs killed with it, the Horses that were ridden into the *Water* beyond the Place, where this *green Substance* floated, drunk without any hurt; and that also, during the same Season, the *Water* in the Streams, that flow from it, are *wholesome*.

XXIV. 1. There is a little Lake in *Straberrick* on the Lord *Lovel's* Lands, which never freezes all over (even in the most vehement Frosts) before *February*; but one Night's Frost thereafter will freeze it all over, and two Nights then will make the Ice of a very considerable Thickness. I have heard of two other Lakes, one of which, is on Lands belonging to my self, called *Loch Monar*, of a pretty Largeness, which steddily keeps the same Method. There is another little Lake in *Straglash* at *Glencanich* on Lands belonging to one *Chiffolm*; the Lake lies in a Bottom 'twixt the Tops of a very high Hill, so that the Bottom it self is very high. This Lake never wants Ice on it in the Middle, even in the hottest Summer, though it thaws near the Edges: And this Ice is found on it, though the Sun, by the Reason of the Reflection from the Hills, in that Country is very hot; and Lakes lying as high in the Nighbourhood have no such Phænomenon. 'Tis observable also, that about the Borders of this Lake the Grass keeps a continual *Verdure*, as if it were in a constant Spring, and feeds and fattens Beasts more in a Week than any other Grass doth in a Fortnight.

Our famous Lake *Ness* never freezes; but on the contrary in the violentest Frosts, the greater Clouds of Steams do arise from it. And I remember, that at two several Times, I being at *Inverness*, walking in the Evenings along the Bridge over the River *Ness*, a Mist of those Steams coming from the Lake and falling down to us over the River (for there was no Mist in any Place thereabout but on this Lake and River only) our Hair became all white, like the whiteness of a Hoar-Frost, but it was soft and warm; and this was in the midst of Summer and in warm Evenings. Doctor *George Mackenzy* (who lives at *Inverness*) told me, that he observes *Rosemary*, though uncovered, to continue in the Gardens about that Lake's side, notwithstanding the last Winter's long and violent Frosts; whereas a far less violent Winter ordinary kills all the *Rosemary* which is in Gardens that lye in warmer Places, and at the Sea-side: And though I live near it, and in a better Soil and warmer Situation, yet any *Winter*, more than ordinary cold, kills my *Rosemary*, though covered over with *Straw* and *Litter*. This he attributes (and I think on good Ground) to the Warmth occasioned by those *Steams* that frequently arise from that *Lake*.

In *Glevely*, at a Place called *Achigniglum*, there is a little Rivulet, which so turns *Holly* into a *greenish Stone*, that they ordinarily make Moulds of it for casting of Balls for Fuzees, and Tinkers that work in Brasses make both their Moulds and Melting Pots of it, and *Women* their round Wharls for spinning.

ning. May it not be, that by the long Infusion in *Water*, descending from Hills, which perhaps abound in Marle, capable to be resolved into small Particles by the constant washing of the *Water*; may it not be, I say, that these little Particles do intrude into the cleansed Pores of the *Holly*, and so make up that *soft Stone*? And any Thing ligneous remaining of the very hard Timber, being all incrustated with this Marle, may it not thereby be guarded from the Action of the Fire?

By Mr. J.
Fraser, n.
254. p. 230.

2. The *Lake Ness*, according to Highland Tradition and Bards, has its Name from one *Nysus* an *Irish Hero* that fix'd a Colony in *Strathbarie*, with *Dornadillo* his Wife. The Promontory, upon which he had his Residence, is to this Day call'd *Down Dearnill*; and he being the first that ever offered to set out Boat or Barges upon this Lake, it is after him called *Loch-Ness*. It is 24 Miles in Length, and in most Places two in Breadth. One *George Scot*, tried 500 Fathoms, and *Capt. Orton* a whole Barrel of Plum-line, but found no Bottom. The Banks of this Lake ascend high and mountainous, with Woods. The Lake never freezes, which is imputed to the many great Springs and Fountains in it; the only Fish in it is *Salmon*. This *Lake Ness* discharges it self in a River of the same Name, six Miles in Length, which runs slowly yet never freezes, but still smoaks with Frost: And from this Smoak is spread a Fog over all the adjacent Country.

On the side of *Loch-Ness* stands the famous Castle of *Urghart* upon a Rock; the great Ditch round it was for the most part cut out of the Rock, and received the *Water* of the Lake. This Castle consisted of 7 great Towers, and 'tis said was built by the *Cuminees*, but had its Overthrow by King *Edward* the First of *England*; and nothing remains now but one Tower to the East.

To the *Westward* of this Castle about 4 Miles, upon the side of *Loch-Ness*, stands that great Mountain *Meal fuor vouny*, of a round, neat, high Shape; it will be two Miles of perpendicular Height from the Lake. Upon the very Top of this Hill there is a Lake of cold fresh Water, about 30 Fathoms in Length and six Broad, no Course or Stream running to it or from it. I plum'd with 100 Fathom of small Line but could find no Bottom. It is always equally full, and never freezes.

About 23 Miles West from the End of the River of *Ness*, there is a Forest called *Affaruck*, in which there is a Mountain call'd *Glenin-tea*; and on the North side, under the Shade of a great sloping Rock stands a Lake of fresh Water, call'd *Lochan Wyn*, or *Green Lake*, 18 Foot in Diameter, about a Fathom deep. This Lake is always cover'd with Ice, Summer and Winter.

XXX. 1. It is generally agreed by all the Inhabitants thereabouts that *Lough-Neagh* has a petrifying Quality: But that no Wood will petrify in it except *Holly*. It is also asserted with some Probability, that the Earth about the *Lough* has this petrifying Quality: For I am certainly informed, that a Gentleman of the Country about this *Lough*, a little before the Rebellion, cut down some Timber for building, and amongst others cut down a large *Holly Tree*, but being diverted by the Rebellion from building, his
Timber

Lough
Neagh in
Ireland; by
Mr. Will.
Molyneux.
1758. p. 552

Timber lay on the Ground in the Place where it was fell'd, upon the Banks of the *Lough*, all the miserable Time of the War, till at last the Kingdom being settled, the Gentleman went to look for his Timber, and found the other Timber overgrown with Moss, and the *Holly* petrify'd, tho' the Water of the *Lough* had never reached it.

And perhaps the *Holly* it self, that grows upon the Banks of this *Lough*, may be more apt to be petrify'd, than the same Wood growing other where, and brought thither, and put into the *Lough*; for certainly if the Ground has this Quality, this is very likely to follow.

That what we call *Lough Neagh Stone*, was once *Wood*, is most probable on these Accounts. *First*, It will not stir with *Acids*. 2. It will burn and flame; and the Smoak of it smells like the Smoak of Wood. 3. When burnt it betrays the very Grain of Wood with the other Vessels belonging to *Vegetables*. 4. I have many of them of various Degrees of *Petrification*; some that have clearly lost the Colour of Wood, and are become perfectly black, and very hard; others that are not so black nor hard; but one more especially was sent me about a Year ago, which is a Parallelopiped, of about 4 Inches long, and an Inch thick; cut, I suppose, whilst Wood, in that Shape purposely, whose outward Coat is very black, and smooth; but this is merely superficial, for being cleft longwise through the Middle, (which it suffered far more easily than that which is more thoroughly petrify'd) I there discovered the whole Body perfectly of the Colour and Grain of *Holly*, for I can scrape it with my Nail; but what was most surprizing in it was, the Discovery of the *Pith*, as plainly and as perfectly distinct in Colour and Texture from the rest (but it also was petrify'd) as it could possibly have been seen in the natural Wood.

I never have seen nor could hear of any Part of the Stone in the least resembling Iron.

I have used some Endeavours to procure a Piece of this *Lough Neagh Stone* to which the Wood was yet fastened, but I never could attain it, tho' some assert they have seen Pieces two or three Foot long, with about eight or ten Inches of *Stone* and the rest Wood. Tho' I am apt to believe this may be stretching the Matter too far, for I conceive that that Humour that petrifies one Part, when it begins to operate, insinuates it self soon throughout the whole Body.

'Tis observed that this petrifying Quality is not equally diffused throughout the whole *Lough* (which is about 15 or 16 Miles long, and 8 or 9 Miles broad in all Places) but is most strong about that Part where the *Black Water* (a River so called) empties it self into this *Lough*, that is about the South West Corner; as likewise it is said to be more strange about the Edges of the *Lough*, than farther into the *Water*.

I have found upon Trial, that this Stone is not *Magnetical*, for it will not stir a *Needle*, or *Steel-filings*, neither will it apply to the *Magnet*, in *Powder* or *Calcined*. n. 166. p. 320

Upon farther Trial I find, that though it will not apply to the *Magnet*
T r 2 Crude,

Crude, yet being *Calcined* it applies most briskly: The occasion of my former Error being, that I did not *Calcine* it long enough.

By Mr. Edward Smith,
n. 174. p.
1108.

2. No Experiment, or Observation yet made, (that I can hear of) can prove that this *Lough* has really the Quality of petrifying Wood; or that the *Water* does any way help or promote the Petrification. On the contrary a neighbouring Gentleman of good Credit and Worth, about 19 Years ago, stuck two *Holly Stakes* (a *Wood* which all agree will soonest petrify in this *Lough*) in two several Places of the *Lough*, near that Place where the upper Band enters into it; and that Part of the Stake, which for so long Time has been washed by the *Water*, remains there without any Alteration, or the least Advance towards Petrification. It is reported indeed that the *Water* has this Virtue, especially about those Places, where the *Black Water* discharges it self into the Lake: But it seems evident from the very Nature of liquid Bodies, that any Virtue received in one Part must necessarily be diffused through the whole, at least in some Degree; and therefore there is good Reason to believe, that the *Water* is wholly destitute of this petrifying Quality.

But that this Virtue is certainly, if not only, in the Ground or Soil, I judge for these Reasons; that there are many *Stones* turned up daily, especially at their breaking up new Ground, which we cannot in any probability think were brought thither: They are often found at two Miles Distance from the *Lough*, seldom farther, in great Numbers, and very deep in the Ground; and a Gentleman (on whose Credit I received the Information) saw a Stump of a *Tree* digged out of the Ground at a small Distance from the *Lough*, which by handling of it he found to be petrify'd: He assured me the Roots and all were Stone, and altogether like those *Stones* that are ordinarily found, and go by the Name of *Lough-Neagh-Stones*. This Gentleman was of Opinion these were *Lapides sui generis*, 'till this Observation convinced him. And that these *Stones* were once Wood, is, I think, very certain, for they shew the plain *Vestigia* of Wood; they likewise burn, cleave; *Filings* of this *Stone* thrown into the Fire emit a *fragrant Smell*; and they cut kindly with a Knife, though not so easily as other Wood.

That not only *Holly*, but also other *Wood* has been petrify'd about this *Lough*, and in the *Soil* adjacent, I have sufficient Grounds to conjecture on this Account; because some Fishermen, being Tenants of a Gentleman from whom I had this Relation, told him, they had found buried in the *Mud* of this *Lough* great *Trees*, with all their *Roots* and *Branches* petrify'd; and some of that Bigness, that they believed they could scarcely be drawn by a Team of Oxen. They broke off several Branches as big as a Man's Leg, and many bigger, but could not move the great Trunk. By this Bulk of it, I guess it to be *Oak*, no *Trees* in that Country, these excepted, growing to that prodigious Bigness; at least 'tis certain that *Holly* never grows to that Bigness.

Two Gentlemen of the North told me, that they themselves had seen the same Body partly *Wood* and partly *Stone*: But the only Reason for thinking so, being the diversity of Colours, which might well enough proceed from several Degrees of Petrification, we may properly think them de-

+

ceived;

ceived; for they made no *Experiments* on that Part which they reputed *Wood*.

The *Bark* is never found petrify'd, as I am informed by a diligent Inquirer, but often something rotten about the Stone answerable to the *Bark*.

XXVI. A Gentleman tells me, that he hath met with a place in *England*, where, tho' there be no petrifying Spring, (for that I particularly asked) *Wood* is turned into *Stone* in the sandy Earth it self, after a better Manner than by any *Water* I have yet seen. I find it to be a very odd Substance, wonderfully hard and fix'd. Here is a certain Stone, that is thought to be petrify'd *Bone*, being in Shape like a *Bone*, with the *Marrow* taken out; but with a fit *Mensstruum*, I found that I could easily dissolve it, like other soft Stones. And possibly it may prove as fit as *Osteocolla*, for the same medicinal Uses.

XXVII. From the *But* of a growing Elm near *Wadley* (a Mile from *Farrington* in *Berks*) one of the spreading Claws having been formerly cut off with an *Axe*, that Part of the *But* from whence the same was severed, being about $1\frac{1}{2}$ Foot above Ground, and inward within the Trunk of the Tree, hath contracted a petrify'd Crust, about the thickness of a Shilling all over the woody Part within the *Bark*; the Marks of the *Axe* also remaining very conspicuous, with this petrify'd Crust upon it.

XXVIII. We have some Waters in *Scotland* that petrify. Upon the North side of the *Firth* of *Forth*, some 8 Miles from the City, there is a Cove close upon the Sea, the Roof of which is covered with a *Stalagmites* a Foot deep, like the Fringe of a Bed; the upper Coat is of a Sea-colour, the Juice is as white as the *Sal Prunelle*; the Water which droppeth from it, if it touch the Skin, maketh it smart. Near to this same Cove, is a Piece of an hollow Rock, which within, from the Top to the Bottom, is full of so many Orders of Columns, resembling the Pipes of a Church Organ, and some of different Figures, I broke a small one and found it somewhat hollow in the Middle. All the Ground in this Place is full of *Lime-stone*.

XXIX. As I travell'd over *Stanemore* in *Yorkshire*, I observ'd the River *Greatah*, (a River about half as big as *Charwel* at *Oxford*) run under Ground for about a Mile, so that we pass'd over it dry Foot. The Passage under Ground is but narrow; so that in Winter when the Streams are high, it keeps the Channel above Ground.

XXX. At some Leagues Distance from *Gottenburgh* in *Sweden*, that River rushes down from a prodigious high *Precipice* into a deep *Pit* with a terrible Noise, and such a mighty Force, that the Masts (which are floated down this River to *Gottenburgh*) usually turn topsy-turvy in their Fall, and do often fly to pieces when dashed against the Surface of the *Water* in the *Pit*. This occurs if the *Mast* falls side ways upon the *Water*: But if they fall end ways, they dive so far under Water, that (according to my Information, they rise not again

again for $\frac{1}{2}$ Hour; others $\frac{1}{2}$ Hour; several $\frac{1}{2}$ of an Hour; and some a whole Hour and upwards. The *Lake* or *Pit* into which they fall has been often founded with a Line of some hundred Fathoms long, but never could they find any Ground.

River Water
recovered af-
ter stinking,
by . . . n.
127. p. 652.

XXXI. Tho' it be commonly reputed peculiar to the *Thames Water* alone, upon stinking, to be recoverable or portable again; I can affirm upon my own Knowledge, that Water taken a-board at *New-London* in *New-England*, tho' in 8 Days time it stunk intolerably, yet when we came to *Virginia*, it recovered so perfectly, that I made no scruple to drink of it in Harbour, even when we had fresh Water newly brought from Shore; nor could I easily perceive it had any Relicts of its late Corruption.

Inundations
in Gascoyne,
by M. Ph.
Col. n. 1. p. 9.

XXXII. 1. In the Beginning of *July* 1678, after some gentle rainy Days, which had not swelled the Waters of the *Garonne* more than usual, one Night this River swelled all at once so mightily, that all the Bridges and Mills above *Toulouse* were carried away by it. In the *Plains* which were below this Town, the Inhabitants who had built in Places which by long Experience they had found safe enough from any former Inundations, were by this surprized, some were drowned, together with their Cattle, others had not saved themselves but by climbing of Trees, and getting to the Tops of Houses; and some others who were looking after their Cattle in the Field, warned by the Noise which this horrible and furious Torrent of Water (rowing towards them with a Swiftneſs like that of the Sea) in *Bretaigne* he means, made at a Distance, could not escape without being overtaken, though they fled with much Precipitation: This nevertheless did not last many Hours with this Violence.

At the same time exactly, the two Rivers of *Adour* and *Cave*, which fall from the *Pyrenean Hills*, as well as the *Garonne*, and some other little Rivers of *Gascoyne*, which have their Source in the *Plain*, as the *Gimone*, the *Save*, and the *Rat*, overflowed after the same Manner, and caused the same Devastations. But this Accident happen'd not at all to the *Aude*, the *Ariege*, or the *Arise*, which come from the Mountains of *Foix*, only that they had more of the same than those of the *Conserunt*, the *Comminge*, and the *Bigorre*.

M. Martel, by the Order of *M. Foucault*, hath searched after the Cause of this *Deluge*, being assur'd that it must have had one very extraordinary. For all who had seen the Circumstances agreed, that it had rain'd indeed, but that the Rain was neither so great, nor lasted so long, as to swell the Rivers to that Excess, or to melt the Snows off the Mountains.

But the *Nature* of these Waters, and the Manner of their flowing from the Mountains, confirm'd him perfectly in his Sentiments. For, 1. The Inhabitants of the *Lower Pyreneans* observ'd, that the Water flowed with Violence from the Entrails of the Mountains, about which there were opened several Channels, which forming so many furious Torrents, tore up the Trees, the Earth, and great Rocks, in such narrow Places where they found

not a Passage large enough. The Water also which spouted from all the Sides of the Mountain in innumerable *Jets*, which lasted all the Time of the greatest overflowing, had the Taste of the Minerals.

2. In some of the Passages, the Waters were stinking, as when one stirs the Mud at the *Bottom* of the mineral Water, in such Sort, that the Cattle refused to drink of it, which was more particularly taken notice of at *Lombex*, in the overflowing of the *Save* (which is one of the Rivers) where the Horses were 8 Hours thirsty before they would endure to drink it.

3. The Bishop of *Lombex* having a desire to cleanse his Gardens, which the *Save* passing thorough by many Channels by this overflowing, had fill'd with Sand and Mud; those which entred them felt an Itching, like to that which one feels when one baths in *Salt Water*, or washes one's self with some strong *Lixivial*. This *Itching* could not be produc'd by either *Rain* or *Snow Water*, but by some mineral Juice, either *Vitriolick* or *Aluminous*, which the Waters had dissolv'd in the Bowels of the Mountains, and had carried along with it in passing through those numerous Crannies.

For these Reasons, M. Martel believes the true Cause of this overflowing to be nothing else but *subterraneous Waters*. And to explain the Means of this *Irruption*, he supposes that there is in the Earth a great Number of *Basins*, *Cavities*, or great *Receptacles* of a vast Extent full of Water, from which by diverse Issues into lower Passages there gets and runs out Water enough to furnish that which runs above the Earth, during the Seasons that it rains little or nothing.

One cannot well doubt of the Truth of this Supposition, if he considers, 1. That in *Mines* as well as in *Pits*, the more one digs, the more abundance of *Water* is met with. 2. That there are *Rivers* that the *Earth* swallows, as that of *Guadalquivir* in *Spain*, and others that gush out of it complete *Rivers*. 3. That there are *Gulphs* in diverse Parts of the Sea. 4. That there are *Lakes* without *Bottoms*, consonant to what P. Kircher remarks in his *Mundus subterraneus*, which diminish not at all, and yet receive little or nothing of *Water* from above. Such as are in the same *Pyrenean Mountains* in the *Lake* of *Berwale* of *Barboian*, and *St. Pé*. 5. And to conclude, That there are found in *Caves* vast *subterraneous Lakes*; as amongst others, that in a Cave near *Grenoble*, of which Francis the First had the Curiosity to desire to know the *Extent*, having caused a *Boat* to be made for this Purpose. Hence we must conclude, that the inner Parts of the *Earth* are like a Sponge dipped in *Water*, and soaked on every Side; or like our Body fill'd with differing Vessels which are the Canals, through which the Blood is communicated to the whole Body.

This being so, 'tis not at all difficult to understand how the *Earth* thus constituted may suffer, in Process of Time, great Changes within its Bowels, as well as on its Superficies, where the Parts of Mountains and vastly great Rocks separating and tumbling down, crush sometimes whole Towns, as it happen'd in the Year 1618, to the Town of *Pleurs* in the *Valtoen*, by the Fall of a Rock which hung over that Town. This Matter is more easily to be done in the Bowels of the *Earth*, because the *Waters* or *subterraneous Rivers* do soak, and

and by degrees undermine the Parts of the *Earth*, which uphold the heaviest *Mountains*; whence it must necessarily follow, that these same *Mountains* must sink down in Proportion to the *Mafs* they have lost. And 'tis certain that somewhat like this happen'd in these *Mountains*, for the People which inhabited those Parts, have seen the *Earth* cleft in diverse Places, and have observ'd also, that in some Places there have happen'd *Foundering*s of the *Earth* for a very considerable Extent, one Part of the *Mountain* being separated, sunk down, which appeared by the profound *Clefts* many Feet deep, but of little Breadth. So this *Mafs* of the *Mountain* in its settling all at once upon the *Water* of the *Gulphs* or *subterraneous Lakes*, which are under the highest *Pyrenean Mounts*, in all the Extent they take up from *Le Foix*, even to *Bern*, do force the *Water* to gush out altogether with great Violence to the same Quantity with the Bulk of that Part of the *Mountain* which is settled in the *subterraneous Lakes*, which is the Cause of this prodigious overflowing.

But that which will not suffer me to doubt at all but that there was some such *subterraneous* tumbling down, is this, that 3 Months after this furious *Inundation*, that is to say, about the end of *September*, there happen'd a second overflowing in some Places near to those where the first happen'd, which made also great Spoil, particularly that which came from the River of *Ariege*. And 'twas then remarkable, that a Fountain that runs from a Rock upon the *Lot*, near the *Cahors*, considerable for the Abundance of its *Water* which turns 3 Mills at its very Source, became all red, which was never seen before in the Memory of Man.

Some Effects
of Vitriolate
Waters, by
Mr. J. Beau-
mont, Ph.
Coll. n. 2, p.
6.

2. One *William Dally* an able Miner, being employ'd at *Week* in *Glocestershire*, about 2 Miles from *Kenysbam*, to renew an old *Work* which was about 6 Fathom deep, and was more than half full of *Water*, he drew what he could out with a *Bucket*, and then he went down into the *Mine*, to clear out the Remainder. Having stood in the *Water* some Days, his Legs began to itch extremely, and swell'd very much, and at length broke out into Sores. I enquir'd of him how the *Ore* lay in its *Mine*, and he told me the Vein of *Ore* grew in the Middle of a Vein of *Sulphur* (as he call'd it) that is, *Marchasites*, which was about a Yard wide; from this I easily gathered, that the *Waters* in the *Mine* having stood a long Time on that large Bed of *Marchasites*, was strongly impregnated with the *Vitriolate Salts*, which abound in them, and was the Cause of the itching and swelling of his Legs.

An Inunda-
tion in Ire-
land, by Dr.
Hook, Ph.
Col. n. p. 1.

XXXIII. June 26th, 1680. An *Inundation* happen'd not far from *Londonderry* in *Ireland*, more monstrous than that in *Gascoygne*. 'Tis suspected that both proceeded from some extraordinary Change in the *subterraneous Caverns* of those Hills from whence the *Water* gushed, very few *Mountains* being without them.

Inundations
in Yorkshire
by Mr. R. P.
n. 245. p. 382.

XXXIV. 1. The *Inhabitants* of *Kettlewell* and *Starbotten*, in *Craven*, in the County of *York*, suffer'd a very great Loss in June 1686, by a sudden overflow of *Water*. The Towns are situate under a great Hill on the East and West; the Country is very mountainous and rocky. The Descent of Rain

was

was after a Thunder-clap, for about the Continuance of an Hour and half with extraordinary Violence, and by several Eye-witnesses the *Rock* on the East-side open'd visibly, and Water they beheld thence into the *Air* the height of an ordinary Church-steeple, so that the *Current* of *Water* came down the Hill into the respective Towns, as in one entire Body, and with a *Breast* as if it would have drown'd the whole Towns, several Houses were quite demolished, and not a Stone left; others gravell'd to the Chamber-Windows; some Inhabitants driven until this Day from their Habitations; the *Current* of the *Water* running thro' their Houses; mighty Rocks descended from the *Mountains* into the *Valley*, and there lay unmoveable; many fair Meadows covered with Sand and Stones, that the Worth of the Soil will not regain the same; Household-goods taken away into the great River of *Wharfe*, and so lost, besides many quick Goods. The Loss reputed to be many thousand Pounds; many Families quite ruined, others in Part only.

There have been two other Floods since the first, tho' not so great and dangerous. The *Becks* or *Currents* of *Water* which run thro' these Towns, were so gravell'd up by the first Flood, that the Passage is much altered, and cannot be regain'd, though there have been many Hundreds of Men set to do it.

2. March 22^d 169^e, At half an Hour after 12 a Clock, being calm, but a little rainy Weather, the River which passeth by the plain Ground of *Noordwyck*, did in the Space of a quarter of an Hour swell to that height, that the *Sugar-Mill*, the *Sugar-work*, and almost all the said Ground was thereby ruined, the most part of the *Sugar-Canes* being rooted or torn out of the Ground by the Violence of the *Torrent*. We cannot imagine whence so sudden a swelling of this River has been caused, while the *Rain* not being very hard, could not be of that Effect; for in such a Case, it should have continued longer; for about 12 a Clock, when the Company's Servants assembled for their Dinner, the Water of the *River* was at its ordinary Height, and before they had half dined all the Country was overflowed by the Water, viz. one Foot higher than 2 Years ago, by Reason of the *Hurricane*, when we had as violent a Storm as ever we heard of. And at one a Clock all the extraordinary Water was gone, and the River again at its ordinary Height. There has been no *Earthquake* that could cause it, neither was there any such Thing in other Rivers.

In Mauritius
Island, By
M. Roel of
Diodati; n.
242. p. 268.

XXXV. In Order to compare the Quantity of *Rain* with the Quantity of *Water* running away in *Springs* and *Rivers*, it is necessary to measure these two Sorts of *Water*. Those that make Profession of governing and conveying *Spring-Waters*, say that a Cubick Inch of *Water* yields in 24 Hours, 144 *Muids*, (the Name of a *French Measure* holding 280 *French Pints*;) others say, it yields but 70 of that Measure.

The Origin of
Fountains
and Rivers,
by M....n.
119. p. 447.

But I have Reason to believe, that it yields 83 of this Measure, and follow those that say, that a Vessel of 2 Foot deep, long and broad, holds one *Muid* of *Water*.

And therefore if a *Conservatory* should hold 3378 *Muids* of *Water*, it would furnish for a whole Year a sufficient Quantity to make an *Inch* of *Water* run constantly. As for the Measure of *Rain-water* I have found by *Observations*, that from *Oct.* 1668, to *Oct.* 1669, there had fallen so much of it as mounted to the height of 18 *Inches* 7 *Lines*; and from the same Month 1670, to the same Month 1671, there happen'd only so much as came to the height of 8½ *Inches*; and from *Jan.* 1673, to *Jan.* 1674, to the height of 27½ *Inches*. Of which, taking the *Medium*, we have 19 *Inches* and 2½ *Lines*.

This suppos'd, let us estimate some River, as it runs from its very *Source* to a Place where some *Rivulet* enters into it, and see, whether the *Rain-water* that falls about the Course thereof, if it were put into a *Conservatory* would be sufficient to make it run a whole Year. In order to this, I have considered the *Seine*, which from its *Source* to *Ainay le Duc* is about 3 *Leagues* long, and the sides of its Course extend themselves on the Right-hand and the Left about 2 *Leagues* on each side, where there are other little Rivers that run another way: And, since that those *Rivulets* need *Water* to maintain them as well as the *Seine*, I will count but half that Space of the Sides, and say, that the Place where the *Seine* passes hath from its *Source* to *Ainay le Duc* three Miles long, and two Miles large. Whereupon I say farther, if a *Conservatory* were made for this Bigness, it would be 6 Square *Leagues* in Surface, which being reduced to *Fathoms*, would make 31245144 *Fathoms* in Surface. In this *Conservatory*, imagine that during a whole Year there has fallen *Rain* to the height of 19 *Inches* 2½ *Lines*, as was said before. This Height of 19 *Inches* and 2½ *Lines*, gives 280899942 *Muids* of *Water*, or thereabout, according to the Measure suppos'd.

All this *Water* thus collected is that Stock which is to serve to make this *River* run for a whole Year, from its *Source* to the Place before named, and which must also serve to supply other Occasions and Losses, such as are the feeding of *Trees*, *Herbs*, *Vapours* and extraordinary Swellings of the River whilst it rains, and *Deviations* of the *Water* running another way.

Concerning the Measure or Estimate of the *Water* of this River, it would be difficult to find it just and precise, and to determine what Quantity it furnishes. Yet so far as I was able to judge, it can have no more than 1000 or 1200 *Inches* of *Water* always running, compensating the lesser Quantity it hath at its *Source* with the greater it hath towards *Ainay le Duc*: The which I so judge by the Comparison I make of these Waters with those of the River of the *Gobelins*, in the Condition wherein it is towards *Versailles*, where it hath 50 *Inches* of *Water*, according to the Measure taken of it. So that I esteem it will be enough to allow Twenty four or Twenty five Times as much to our River. For the Channel of it is to be 4 or 5 *Fathom* large, and for Depth it is but shallow, it carries no Boats, and serves only to float down some loose *Billers*.

These Particulars being thus suppos'd, I say, that 1200 *Inches* of *Water* do furnish in 24 Hours 99600 *Muids* of *Water* after the rate of 83 *Muids* to an *Inch*, that is, 36436000 for a whole Year. And therefore taking this Quantity

ty of 36½ Millions from the 280 Millions, that falls into the *Conservatory*, above described, there will remain yet above 188 Millions of *Muids*, which amounts to almost 5 Times as much, and which serves to furnish for the Losses, Diminutions, and other Wastes above taken notice of. So that there needs but the 6th Part of the Rain and Snow-water that falls in a Year, to run continually thro' the whole Year.

Now if these *Rain-Waters* are sufficient to make one River run, they may also suffice for all the rest in Proportion; considering especially, first, what remains for waste, which is superabundant; and *secondly*, what little Space I allow to both sides of the River's Course, which is but of one League on each side. For Rivers are not commonly two Leagues near one another.

It may be objected, that there are Countries where it rains but seldom, but somewhere it rains not at all, and yet there are considerable Rivers. But I answer, that the Rivers of those Countries where it rains but seldom, do not run continually, being only big in Winter, but in Summer almost quite dried up. The Reason of both which Effects is, that they being nigh some high Mountains whence they come, the Snow that falls in Abundance on those Hills, and is melted afterwards, is able, as long as that Water lasts, to make them run abundantly in Winter, leaving them dry when it ceases in Summer.

As for the Countries where it rains not at all, there are but few of them in the World. The *Torrid Zone* (where that may be more true than any where else) is a *Climate* abundantly moistned with *Rains* twice a Year, and it may be more than these *Northern Countries*, at least in greater Plenty at certain Seasons. But if there should be any Countries where no Rain at all should fall, that will not hinder the running of *Rivers* there, because they may have their Sources in other Countries where it rains, as the *Nile* in *Egypt*, where it rains not.

XXXVI. 1. About 2 Leagues from *Paderborn*, is a treble Spring called *Methorn*, which has 3 *Streams*, two whereof are not above one Foot and an half distant from one another, and yet of so differing Qualities, that whereas one of them is limpid, blewish, lukewarm, bubling, and holding *Sal-Armoniack*, *Oebra*, *Iron*, *Vitriol*, *Allum*, *Sulphur*, *Nitre*, *Orpiment* used against *Epilepsies*, bad *Spleens* and the *Worms*; the other is Ice, cold, turbid, and whitish, much stronger in *Taste*, and heavier than the former, holding much *Orpiment*, *Salt*, *Iron*, *Nitre*, and some *Sal-Armoniack*, *Allum* and *Vitriol*; of this all Birds observed to drink of it do die; which I have also privately experimented by taking some of it Home, and giving it to Hens, after I had given them *Oats*, *Barley*, and *Bread Crumbs*: For soon after they had drunk of it, they became giddy, reeled and tumbled upon their Backs, with Convulsion Fits, and so died with a great Extention of their Legs. Giving them common *Salt* immediately after they had drunk, they died not so soon; giving them *Vinegar* they died not at all, but 7 or 8 Days after were troubled with the *Pipp*. Those that died being opened, their *Lungs* were found quite shrivel'd together. Yet some Men that are troubled with *Worms*, taking a little

Mineral
Springs,
about Pader-
born in Ger-
many. by
..... n. 7.
p. 133.

little Quantity of it, and diluting it in common Water, have been observ'd by this means to kill the *Worms* in their Bellies, so that a great Number of *Worms* came from them; whereupon tho' they are sick, yet they die not. As to the 3^d Stream that lies lower than the other two, about 20 Paces distant from them, it is of a greenish Colour, very clear, and of a four sweet Taste, pleasing enough. It hath about a middle Weight between the other two, whence we guess that it is mixed of them both, meeting there together; to confirm which, we have mixed equal Quantities of these Two, with an Addition of a little common *Well-water*, and have found, that they being stirred together, and permitted to settle, made a Water just of the same Colour and Taste of the third Stream.

At Basil, by
..... ib. p.
134.

2. At *Basil*, the Spring running in the *Gerbergasse*, (or *Tanners-street*) from *St. Leonard's Hill*, is of a blewish Colour and somewhat troubled, holding *Copper*, *Bitumen*, and *Antimony*, about 3 Parts of the first, one of the 2^d, and two of the last; and have been examin'd by skilful Persons. Our *Tanners* do water their Skins in it, and being a well-tasted and wholesome Water, it is both much drank, and used to bath in.

There are two others, called *Randulph's Well*, and *Brun Zam Brunnen*, very observable: The former of them having a Camphory and drying Quality, and used against hydropical Distempers; the latter containing some *Sulphur*, *Salt-petre* and *Gold*, and being an excellent Water to drink.

Near Yeoville, in Somersethshire, by Dr. J. Beal, n. 18. p. 323. n. 20. p. 359.

3. Mr. *Philips* of *Montague* has in his Pastures of *Socke*, about 3 Miles from *Yeovill*, a large Pool to which Pigeons resort, but the Cattle will not drink of it, no not in extream want of Water. To the Taste it is not only brackish, but hath other loathsome Tastes. In a *Venice* Glas it looked greenish and clear, just like the most greenish Cyder as soon as it is perfectly clarified. I boil'd a Pint of it in a Posnet of Bell-metal, and suddenly it yielded a thick Froth, having somewhat of a vitriolate Taste. Suffering the Water to be boiled all away, it left much of the same on the Sides and Bottom of the Posnet.

On Malvern Hill in Herefordshire, By Dr. J. Beal; n. 20. p. 358. n. 57. p. 1161.

4. There is a Spring near the top of *Malvern Hill*, having a long and old Fame for healing of *Eyes*; and about a Furlong lower is another healing Spring. When I was for some Years molested with *Tetters* on the back of one and sometimes of both my Hands, notwithstanding all Endeavours of my very friendly and skilful Physicians, I had speedy healing from a neighbouring Spring of far less Fame. Yet this Spring healed very old and ulcerous Sores on the Legs of a poor Fellow, which had been poisoned by *Irons* in the *Goal*, after other Chirurgery had been hopeless. And by many Trials upon my Hands and the *Tetters*, I was persuaded, that in long *Droughts*, and lasting dry *Frosts*, those Waters were more effectually and more speedily healing, than at other Times. I held this Water in my Mouth till it was warm, and perchance somewhat intermingled with *Fasting-spittle*, and so dropping it upon the *Tetter*, I there could see it immediately gather a very thin Skin upon the raw Flesh, not unlike that which is seen to gather upon Milk over a gentle Fire. This Skin would have small Holes in it, thro' which a Moisture did issue

in

in small Drops, which being wiped away, and the Water continued to be drop'd warm out of the Mouth, the Holes would diminish, and at last be all quite healed up.

For the Eye-Waters, I conceived them more strongly *Tersive*, and clearing the Eyes; and they had a rough Smartness, as if they carried Sand or Gravel into the Eye.

5. I think the Waters we call *Chalybeate*, and particularly this at *Farrington*, to be impregnated principally from the *Vitriol*, or Salt of Iron, which is very Volatile; so that little of it can be found by Evaporation of a great Quantity, or from the precipitated Sediment. I put 4 Ounces of ordinary clear Water into a Glas, and impregnated it with a known Proportion of Gall: Then by degrees I let fall into it the Salt of Iron, until I found it thereby as deeply tinged Red, as the same Quantity of *Farrington-waters* would be by the same Proportion of Gall: The Quantity of the Salt of Iron that performed this, was near two Grains. This Water, so tinged, tasted and smelted just as the natural Water from the Spring with Gall did: If I added a greater Proportion of Salt, it would make it nauseous and *Emetical*.

At Farrington in Dorsetshire; By Dr. Highmore, n. 56. p. 1136.

It begins to be in high Esteem for extraordinary Cures of the *Scorbute*, *Asthma*, &c. It hath [as I have found upon Trial] a larger Proportion of the Minerals, than *Astrop-water*; but the Force holds not, if removed from the Spring-head.

n. 51. p. 1039

6. About a Mile and half out of *Durham*, on the North-East-side near *Butterby*, is lately discovered a *Medicinal Spring*, which is this Year much frequented and maybe of great Benefit to the Country. It was found out by Workmen that dug in that Place for Coal. When they were 12 Fathom and an half deep, they discovered this Treasure of *Natural Physick*. They then tried the Rock about 100 Yards off; where they lost themselves much about the same Depth; and instead of Coal discovered a Spring of excellent clear Water, which issues out at the Hole which their Instruments made.

In the Bishoprick of Durham; By Mr. Hugh Todd, n. 163. p. 727.

7. At *Lancarim* in *Glamorganshire*, is a *Medicated Spring*, much frequented from several Counties, Time out of Mind, for the *King's Evil*. There is a Rill of about an Ell broad between two Collines, covered with Wood; about 12 Yards from this Spring, the Rill falls from a Rock 8 or 9 Foot high, which makes a grateful Noise; the Spring (which is exceeding clear) comes out of a pure white *Marle*; tho' I thought there had been no white *Marle* in *Wales*, for the Earth is red. A *Graduate Doctor* hereabouts imputes the Virtue of this Spring to the *Lime-stone*; and says, one of the chief Ingredients of the Doctors for the *King's Evil* is *Lime-Water*.

In Glamorganshire; By Mr. Aubry, n. 233. p. 727.

8. I had a *Mineral Water* sent me, not long since, by Mr. Duncan (a Surgeon) from *Eglingham* in *Northumberland*. I found it turned almost quite Black with Galls, though it had been brought at least 30 Miles by Land-Carriage. After I had slowly, in a Glas, evaporated more than one half of this Water, it still retained the same *atramentous* Quality, and struck yet as deep with Galls as ever; and at last it yielded me a real and genuine *Vitriol*. I say nothing of the *Ocre* which this Water let fall in very great Plenty, that being a Thing common to all *atramentous Waters*.

At Eglingham in Northumberland; By Dr. Cay n. 245. p. 365.

I was surprized at this Phænomenon: For I could not bring my self to think it possible, that the *Pyrites*, lying constantly under *Water*, should ever yield *Vitriol*; and I knew of nothing else (at least in *England*) that I could expect it from. But having lately an Opportunity to visit this notable *Well*, I found our mighty *Rarity*, our *vitriol Water*, to be only one old *Drift* made for the draining of a Row of old wrought *Coal Pits* a little above, and I inform'd my self from some old Men, that had formerly wrought in these *Pits*, that there was Plenty of the *Pyrites* there, by them call'd, *Brass Lumps*; and that this *Drift* was sometimes dry, and sometimes ran with a plentiful Stream; which is as fair and full an Account how this *Water* comes to have *Vitriol* in it, as any one need to desire.

At St. A-
mand near
Tournay; By
Mr. Geoffry,
p. 347. p. 430.

9. There has been found a *Mineral Water*, call'd *St. Amand's-Water*, which has been very much in use the last Summer and Autumn, in all Sorts of Sickneffes, rather for its Novelty, than for its great and extraordinary Properties. It is call'd *St. Amand's Water*, because its Spring is in the Land depending on the *Abby* of the same Name, of the Order of *St. Benedict*, in the Diocese of *Tournay* in *Flanders*; but the *Fountain* is called particularly, *La Fontaine du Bouillon*, for the impetuous boiling of that springing *Water*.

This *Fountain* is situated in a shallow and marshy Ground; the *Bason* of the Spring is 450 Foot square, there is in the *Bottom* of that *Bason* the *Mud* of 20 Foot deep; beyond that they find the *Sand*, which sometimes is very moving and at some other times is very firm. Very often this *Fountain* casts up a great Quantity of *Sand*: And last Year in a little Time it cast up more than 16 Cart Loads of it, by the which all the *Bason* was border'd.

There is to be found 3 Sorts of *Earth*; the first and superficial is black, and burns as *Turf*, with the same Smell; the second is white; and the third has the same Colour as the *Slate*. These two last Sorts of *Earth* do give by *Lixivium*, a Salt like *Sal Gemme*.

This *St. Amand's-Water* in its Spring is clear and *Lukewarm*, and appears much hotter at Night and in the Morning, than the rest of the Day. It has the Smell and Taste like standing *Water*. If it is expos'd to the Air it loses its Smell and Taste in a short Time. By that Facility to lose its Taste and Smell, one may judge that it has a *Sulphur* very *Volatile*; and for that great *Volatility* and *Subtility* it is almost impossible to make any Experiment upon it.

This *Mineral Water* has the same Weight as the *Seine River Water*. It altered not the Colour of the *Syrup* of *Violets*, nor the *Tincture* of *Turne Sol*, *Lime Water*, the *Oyl* of *Tartar*, the *Volatile Spirit* of *Sal Armoniaick* and *Hart's Horn* have whited that *Water*, and have made it a light *Coagulum*.

This *Water*, mixt with the *Dissolution* of *Armonaick Salt*, has not given any Smell. It has not alter'd the *Infusion* of *Galls*. Mingled with the *Solution* of *Vitriol*, has troubled it a little, and has given a greenish Colour, and at length is precipitated a *yellow Powder*.

Acid.

Acid Spirits have not fermented at first with that *Water*, but afterward it has made some little Bubbles, which remained to the side of the Glasses wherein were contained the Liquors.

I have distilled 5 Pints of that *Water*; the distill'd *Water* has not had any Taste nor Smell, and it has not changed the Tincture of *Turne Sol*, neither the *Lime-water*. There remained from that 5 Pints (or 160 Ounces) 70 Grains of *Residue*; the which, by *Lixivium* has given to me 55 Grains of grey Earth, and 15 Grains of white Salt, almost like *Sal Gemme*.

The *Residue* of the evaporated *Water* put upon the burning Coals, has not cast any Smoak, neither has made any *Detonation*; the *Spirit of Nitre* poured upon it, has very much fermented; the *Spirit of Wine* has not extracted any Tincture from that *Residue*.

One may conclude by all these Experiments, that this *Water* has not any *Acidity*, it participates not of *Vitriol* nor of *Alum*; and there is in it but a little Quantity of the white Earth, and less also of Salt very like *Sea Salt*.

They are the Parts of Earth and Salt, which shew themselves in the Mixture of the *Lime-water*, &c. of fix'd or volatile *Alcalis*.

They are the same Parts which begin that light Fermentation in the Mixture of *Acid Spirits*; but that Fermentation is imperfect because of the little Quantity of the Earth, which is drown'd in so great a Quantity of Liquor; in Effect when the *Water* is evaporated, the *Acid Spirits* do ferment very much with the *Residue*.

It appears by the Smell of that *Water*, that it contains a *Sulphur* very subtle, which dissipates it self very easily, and which is not sensible in the Experiments. 'Tis nevertheless to be attributed to that *Sulphur*, the principal Effects which they do attribute to that *Mineral Water*, as of helping in the *Palsy*, &c. In other Sorts of Distempers where the nervous Gender is attack'd; in *short Breath*, and in all Affections of the Lungs; and of remedying many other Infirmities which are caused by the sharp Ferments, the which are sweetned by that *Water*. For the other Properties of it, as of *Purgings*, of taking away Obstructions, of Tempering the hot *Intrails*, &c. it may have the same Effects with common *Water* being drunk abundantly.

One may drink many Glasses of this *Water*, beginning by 4, 6 or 8 every Morning, and augmenting till 12, 18, 20 or more, according as the Stomach is able to support it. This *Water* passes readily by *Urine*, and many Persons are purged by it. Sometimes one may mix with it some *Diuretick Salt*, to make it pass more freely, and for rendring it more *De-obstructive*. At other Times one may put some *Manna* or other Things for making it more *Purgative*. One may wash also in the Mud of that *Fountain*, according to Necessity.

XXXVII. I have observed a *Spring*, that in all the extreame Frosts, that have been these 10 Years, hath yielded a small Stream, which running over a large Tract of Pasture, keeps all the Banks and Borders Green, and free from freezing, dissolving the Snow, and smoaking all the way where it runs.

A Spring that is never frozen; By Dr. J. Beale. n. 56. p. 1139.

XXXVIII. I. The

The Baths in
Somerset-
shire; By Mr.
Jof. Glanvill.
n. 49. p. 977.

XXXVIII. 1. The Country round *Bath* is very hilly and uneven; but the Hills lye in Order; they are generally rocky and Steep from South-West and by West, to North-East and by North: The whole Tract of the Country, within 5 and 7 Miles, abounds with Coal-Mines, more or less. But there are no other considerable Mines that I can hear of, nearer than *Mendip*, which is 10 Miles hence, excepting some of Lead at *Berry* in *Glocestershire*, which lies upon the *North* of this Place, about 4 or 5 Miles distant.

2. The Hills for the most part afford a Free-stone; and on the North-West of *Lansdown* (which hath that Situation to the Town, and is just above it) the Stones digged there are a sort of head Stone, commonly call'd a *Lyas* blue and white, polishable.

3. The *Town* and *Baths* are of very great Antiquity. Besides what I find in very ancient Chronicles to that Purpose, one of our great Antiquaries (Mr. P.) asserts, that these *Baths* were 800 Years before *Christ*: Which if so will give occasion to enquire, how consistent with it that Hypothesis concerning the Cause of the *Heat* of these *Waters* may be, which makes it to be the *Fermentation* of Minerals *in fieri*; and whether it be likely, that the Minerals through which these *Waters* pass, should be in that State of Imperfection so many hundred Years. But this other Opinion seems to me very probable which supposeth the Cause of the *Heat* to be, that two Streams having run through and imbibed certain Sorts of different Minerals, meet at last and mingle their Liquors, from which *Commixture* arises a great *Fermentation* that causes *Heat*; like as we see it is in *Vitriol* and *Tartar*, which when mingled beget an *intense Heat* and *Ebullition*.

4. It is affirmed here, that the *Town* for the most part is built upon a *Quagmire*, though the Places all about it are very firm Ground. Some Workmen, that have been employed in Digging, have found a *Mire* 10 Foot deep, without the *North Gate*, the highest Place of the *Town*, at *Seaven*. The *Earth* between is a kind of Rubbish; sometimes they find *pitching* a Man's length under Ground, and passages for the Water to pass; 7 or 8 Feet down they have met with *Oyster-shells*.

5. The *Town* and *Country* circumjacent, generally abound with *cold Springs*: And in some Places the *Hot* and *Cold* arise very near each other; in one Place, within two Yards, and in others, within 8 or 9 of the main *Baths*.

6. The *Guides* of the *Cross-Bath* inform me, that when there is a great West Wind abroad, standing by the *Springs* they feel a cold Air arising from beneath: If the Wind be at East and the Morning close with a little misting Rain, the *Cross-Bath* is so hot as scarce to be endured, when the *King's* and *Hot Baths*, are colder than usual. In other Winds let the *Weather* be how it will, this *Bath* is temperate. The *Springs* that *Bubble* most are coldest. The *Cross-Bath* fills in 16 Hours, both in *Winter* and *Summer*, without any difference from *Heat* or *Cold*, *Flouds* or *Drought*; that of the *King* in 12 or 14 Hours.

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7. A Man may better ordinarily endure 4 Hour's Bathing in the *Cross-bath*, than $1\frac{1}{2}$ in the others. In the *Queen's-Bath* (which hath no Springs of its own, but comes all out of the *King's*) they have found under a flat Stone, which upon Occasion was taken up, a Tunnel, and a yielding Mud in and under it, into which they thrust a Pike, but could feel no Bottom. In the *King's-Bath* there is a Spring so hot, that it is scarce sufferable, so that they are fain to turn much of it away, for fear of inflaming the *Bath*. The *hottest Spring* will not harden an Egg.

8. The *Bath-water* does not pass through the Body like other *Mineral Waters*; but if you put in *Salt* it purgeth presently: Upon *Settlement* it affords a black Mud, useful in *Aches*, applyed by way of *Cataplasm*; to some more successful than the very *Waters*. The like it *deposites* upon *Distillation*, and no other; nor hath any more been discovered upon all the *Chymical Examinations* that have come to our Knowledge. One Dr. *Afendoff* found, that the Colour of the *Salt*, drawn from the *King's* and *Hot-bath*, was yellow; that which was extracted from the *Cross-bath*, white. This Dr. concluded, that the *Cross-bath* had more of *Alum* and *Nitre* than the *hotter Baths*, which abound more with *Sulphur*. And yet that *Bath* loosens *stunk Sinews*, by which it should seem it abounds not much with *Alum*. It is harsher to the Taste than the other *Baths*, and soaks the Hands more.

9. A Man cannot drink half the Quantity of strong Drinks in the *Bath*, that he can out of it; but if he hath drunk before to Excess, it allays much, and is a great Refreshment to the Body. The *Bath* provoketh *Urine*.

10. They are very useful in *Diseases* of the Head, as *Palsies*, *Epilepsies*, and *Convulsions*; in *Cuticular Diseases*, *Leprosies*, *Itches* and *Scabs*; in all *Obstructions* of the Bowels, as *Spleen*, *Liver*, and *Mesentery*, and the *Schirrosity* and Hardness of those Parts; in most *Diseases* of *Women*; in the *Scurvy* and *Stone*: As to which last, while I am writing, an Alderman of the City assures me, that his Wife, who had been exceedingly troubled with the *Stone*, went into the *Cross-bath* for it, and voided there several *Stones* as big as those of *Olives*, and was never troubled with that Distemper after. The *Bath* is also good in cold *Gouts*, as they call them.

The same Alderman tells me, that it gives him present Ease, when he is troubled with the Fits of it. He uses to go in as soon as the Fit takes him; which then goes off presently, and returns not in a considerable time after: He puts his Feet upon the hottest *Springs* in the *King's Bath*.

But it had a contrary Effect in *hot Gouts*; and some, who are troubled with that Distemper, tell me, that the *Bath* puts them into a Fit, if they go into it without Preparation; or if they have the Fit before, it inflames it more, and sends it about the Body, and disables the Joynt so, that there is no treading on it for the present. Further, the *Bath* is effectual in the *Diseases* of *Children*, particularly the *Rickets*, removing the Humours that proceed from it without Fail. 'Tis also good for *Women*, that are apt to miscarry, if us'd moderately. The *Bath-guides* go in, when they are ready to lye down; and other *Women* of the Town use it ordinarily through-

out their Time, and are never observed to miscarry. It facilitates Deliverance: Besides is very effectual for the strengthening of *broken Bones*, and good in all cold and moist *Distempers* and *Weakness* of *Nerves*, *Stupéfactions*, *Relaxations*, and violent *Pains*: In all which it gives Ease, except the *Lues Venerea*, for in that (except the Malignity be overcome by the Methods of Physick) it exasperates the Pain more. 'Tis an excellent Remedy to remove the remaining *Weakness* in *Gouts*, as hath been remarkably exemplified in old Men, even to the Age of 83 Years.

11. There is no Instance of Cures performed by it in former Times, but we have the Experience of it in ours; yea, and in some others, as in *Dropsies*, *Cachexies*, *Spleen*, &c. In which Cases, they were shy heretofore of using the *Bath*, for Fear of confirming those *Obstructions*, whereas 'tis now found, that their Cure is facilitated by it.

12. The *Bath-guides* live to a very great Age, sometimes to near 100 Years, ordinarily if they are temperate to 70. There are two at this time above 80, a Man and his Wife.

13. In the *Cross-Bath* the *Guides* have observed a certain black Fly with sealed Wings, in the Form of a *Lady-Cow*, but somewhat bigger. They say, it shoots quick in the *Water*, and sometimes bites. It lives under the *Water*, and is never found but in very hot *Weather*. They suppose it comes up with the *Springs*. It is not to be seen elsewhere.

14. The *Cross-Bath* eats our Silver exceedingly; and I am told that a Shilling, in a Week's Time, hath been so eaten by it, that it might be wound about one's Finger. The *Baths* agree (as the Vulgar speak) with *Brass*, but not with *Iron*: For they will eat out a Ring of this Metal in 7 Years, when *Brass* Rings seem to receive no Prejudice at all from it.

15. When Women have wash'd their Hair with the Mixture of beaten Eggs and Oatmeal, this will poison the *Bath* so, as to beget a most noisome Smell, casting a *Sea Green* on the *Water*, which otherwise is very pure and limpid. This will taint the very Walls, and there is no cleansing of it, but by drawing the *Bath*.

16. In Summer the *Baths* purge up a green Scum on the *Top*, but in Winter never; but then leave a Yellow on the Walls.

17. The Walls that keep in the hot *Springs* are very deep set, and large; 10 Foot thick, and 14 deep from the Level of the Street. The *Cement* of the Wall is yellow Clay, Lime and beaten Bricks. In the Year 1659, the *Hot Bath* (a *Bath* particularly so call'd, of equal Heat with the *King's Bath*) was much impaired by the breaking out of a *Spring*, which the Workmen at last found again, and restored. In digging they came to a firm Foundation of factitious Matter, which had Holes in it like a Pumice Stone, through which the *Water* played; so that 'tis like the *Springs* are brought together by *Art*: Whence probably was the *Necromancy* the People of ancient Times believ'd and reported to have contrived and made these *Baths*; as in a very ancient *Manuscript Chronicle* I find these Words: *When Lud. Hidibras was dead, Bladud his Son, a great Nygromancer (so 'tis there writ) was made King, he made the Wonder of the Hot Bath by his Nygromancy; and he reign'd*

21 Years, and after he died and lies at the New Troy. And in another old Chronicle 'tis said, That King Bladud sent for the Necromancers to Athens to effect this great Business; who, 'tis like were no other than cunning Artificers, well skill'd in *Architecture* and *Mechanicks*.

18. It hath been observ'd, that *Leaves*, like those of *Olives*, come sometimes out of the Pump of the *Hot Bath*.

2. These *Waters* have been long famous for the Cure of *Palsies* and *Barrenness*: An Instance of both in one Person, I shall now give you. A Gentlewoman of about 30 or 32 Years of Age, having been married about 10 or 12 Years, and never with Child, was suddenly seiz'd with a *Palsy* on the Left-side, for which (after 8 or 10 Months Tryal of other Means to little Purpose) she was brought to the *Bath*, where (after usual Preparations, and some internal Means) she continued that Season about 6 Weeks; the Winter coming on, she was forced to desist; but (by the Advantage she received) was encouraged to come very early the next Year, and did continue with us the whole Summer, and recovered, in great Measure, the Use of her Arm and Hand, Leg, and Tongue; and not only so, but, in a few Weeks after, she returned to her Husband, conceiv'd with Child, and had (about a Year's and half's Distance between them) 5 Children, following. She shew'd me 4 of them lusty and strong, and well grown for their Age, the 5th died: She herself had no Return of a *Palsy* but is *Infirm*, I think *Consumptive*; she is now about 51 Years old.

XXXIX. At *Baden* a little City in *Austria*, 4 German Miles Southward from *Vienna*, seated on a Plain, but nigh unto a Ridge of Hills, which are the Excursions of Mount *Cetius*, are convenient *Baths*; Two within the Town, Five without the Wall, and Two beyond a Rivulet called *Swechet*.

The *Duke's Bath* is the largest, about 20 Feet square, in the Middle of an House of the same Figure, built over it. The Vapour passes through a Tunnel of Wood, at the Top: And the Water is conveyed into the Bottom of the *Bath*, at one Corner, through wooden Pipes and Trees, under the Town-wall, from the Spring-head, which riseth at a little Distance Westward. The Springs of the rest of the *Bath* rise under them, and are let in through Holes of the Plancher, for all the *Baths* are wainscotted, the Seats, Sides and Bottoms being made of Fir. The Water, for the most Part, is clear and transparent, yet somewhat blewish, and maketh the Skin appear pale in it, as doth the Smoak of *Brimstone*. It coloureth Metals (except Gold, whose Colour it also heightens) turning them black in a few Minutes. The Coyn of this Country, mixt of Copper and Silver, (having $\frac{7}{8}$ of Silver, and $\frac{1}{8}$ of Copper) is in a Minute's Time turned from a White into a dark Yellow, and soon after becomes black. To the Moss and Plants which it washeth, it gives a fine green Colour, and leaves often a Scum upon them, of a Purple mixt with White. As it runs from the Spring-head, it somewhat resembles the *Sulphur River* in the way from *Tivoli* to *Rome*, but is not so strong or stinking, nor doth it incrustate its Banks.

X x 2

I pass'd

Baths in Austria and Hungary; by Dr. Ed. Brown, n. 59. p. 1044.

I pass'd to the Spring-Head (which riseth under a Rocky-hill) about the Length of 40 Yards, through an arched Passage cut in the Rock, which is also a *natural Stove*, (as that of *Tritola* and *Bajæ*) made by the *hot Bath-water* running under it. Most Part of this Cave is incrustated with a white Substance, by them called *Salt-peter*: At the Mouth of the Cave it becomes harder and stony.

I caus'd some of the Pipes, through which the *Bath-water* runs, to be opened, and from the upper Part of the Pipe, I took some Quantity of *fine Sulphur* in Powder, somewhat like *Flowers of Brimstone*; this being as it were sublimed from the Water, and not depos'd, being found in the upper Part of the Pipe. *Oleum Sulph. per Campanam* dropped into this Water, is received into it quietly. *Oleum Tart. per Deliquium*, caus'd an *Ebullition*, as in the making of *Tartarum Vitriolatum*.

The second *Bath*, within the Wall, is that of our *Lady*, about 12 Foot broad, and 24 long. One End of it is under a Church of the same Name. This is fuller of Sulphur than the rest, and more blue, and leaveth a yellow Flower upon the Boards, as the others do a white.

The 3^d is the *New-bath*, out of the Town nigh the Gate.

The 4th, the *Jew's Bath*, which hath a Partition in the Middle to separate the Men from the Women.

The 5th, *St. John's Bath*, of a Triangular Form.

The 6th, the *Beggars Bath*, always shallow, so as they lie down in it.

The 7th, the *Bath* of the *Holy-Cross*, about 2 Fathoms square, chiefly for the *Clergy*.

The 8th, *St. Peter's Bath*, greener than the rest.

The 9th, the *Sower Bath*, set about with Stone-balastres, and covered with a Cupola and Lanthorn. The Water is very clear: In the Stream of this *Bath* I have often colour'd Money black without touching the Water; and staying only in the Room where the *Bath* is, the Buttons of my Cloaths, and what else of Silver the Vapour could come at, were colour'd yellow or guilded: And yet the Water it self once cold, changeth not the Colour of Metals, though boiled in it.

The *bottest* of these *Baths* have not the *Heat* of the *Queen's Bath* at *Bath* in *England*. They use no *Guides*, as with us, but direct themselves with a short turn'd Staff.

Manners-dorff, seated under an Hill on the East Side of the River *Leyta* hath only one *Bath*. It riseth under a Church, built over the Spring-Head.

The Water of it is *lukewarm*, and therefore they boil it in great Coppers, when they desire it *hotter*, and *bath* in Tubs fill'd with this boiling Water. From the Substance, which sticks to the Coppers in boiling, it is collect'd, that it is impregnated with Sulphur, *Salt-peter* and *Chalk*. This Water colour'd the Stones in it of a fair Green like a *Turkois*; and the

Steam of it, which flicks to the Moss under the Church, turns into Drops of Gold or Amber.

Dotis, 2 Hungarian Miles from *Comora* in Hungary, hath also sulphurous Baths, said to be warm in Winter. In *March* and *October*, I found their Warmth very remiss, scarce perceivable. In Colour they are blueish, and to taste, acid. The Queen's Bath, and the great Bath rise in a Marsh, Northward of the Castle.

There is another Bath in the Governour's Garden within the Town. They are used as those of *Manners-dorf*.

At *Banka*, two Hungarian Miles from *Freistat*, in a Meadow, I took Notice of 15 Baths: And there have been more, but the River *Waag* eateth away the Banks, and swallows up the Baths, and into 3 of these 15 it hath also broke in. The Water of these is like to that of *Baden* in *Austria*; it leaves a white Sediment upon the Moss and Places it washeth, and tinctureth Metals black. I stuck some Money into the Ground, over which the Water passeth; that Part which was in the Ground, retained its own Colour, and the other Part in the Bath-water acquired a Coal Black. These Baths are open, and very hot.

The Baths of *Boinitz* nigh the River *Nitra* in Hungary, are of a moderate gentle Heat, much beautified by Count *Palsi* Palatine of Hungary, and all of them covered under one large Roof; the first is the Noblemen's Bath, built of Stone, descended into on all Sides by Stone-Stairs; Four more there are of Wood, but very handsomely and well built.

At *Stuben*, 3 Hungarian Miles from *Newsol*, and 2 from *Chremnitz* near to a Rivulet, are diverse Baths of great Esteem. The Water whereof is clear, and smells of Sulphur, the Sediment green. It colours the Wood over it green and black, but does not change the Colour of Metals so soon as most others. I left Money in it a whole Night, which was yet but faintly coloured. The Springs arise underneath, and pass thro' the Holes in the Plancher of the Baths; the Heat thereof is answerable to the King's Bath in *England*. These Baths are 7.

The first is the Noblemen's Bath; the 2^d, the Gentlemen's Bath; the 3^d, the Country-man's; the 4th, the Country-woman's; the 5th, the Beggar's Bath; the 6th, for such as are infected with the *Lues Venerea*; the 7th, the Bath of the Gypsies; of whom there are many in those Parts. These Baths are in a Plain, encompassed on all Sides with Hills, the highest unto them are towards the East, and it is the same Ridge of Hills, which on the other Side are so rich in Metals.

Glass-Hitten, an Hungarian Mile, or about 7 English Miles from *Schemnitz*, hath 5 Baths; two of which are large. It depose a red Sediment, and incrustates the Wood and Seats of the Bath under Water with a stony Substance; and it guildeth Silver. But the most remarkable of these Baths, is that which is called the *Sweating Bath*, whose hot Springs drain thro' an Hill, and fall into a Bath built to receive them; at one End of which, by ascending, I went into a Cave, which is made a noble Stove by the Heat

of these *Thermae*, and so ordered with Seats, that every one who sits in it, either by chusing a higher or lower Seat may regulate his Sweating, or, enjoy what Degree of Heat he desireth. This Cave as also the Sides of the Bath, are covered by the continual dropping of those hot Springs, with a red, white, and green Substance; the red and green make the best Shew, but the white is used against the Stone, and cureth Ulcers, and sore Backs of Horses.

Eisen-bach, about 4 English Miles from *Glass-Hitten*, and 5 or 6 from *Schemnitz*, hath also hot Baths. I have seen great Trees placed at the Top or Superficies of the Water in these Baths, which have suffer'd Petrification. Here are two convenient Baths, much frequented; and a 3^d, which is made by the Water let out of the former, called the *Snake's Bath*, from the Number of Snakes coming into and delighting in it, when 'tis filled with these warm Waters.

The natural Baths of *Buda* are esteemed the noblest of *Europe*, not only in respect of the large and hot Springs, but the Magnificence of their Buildings.

For the *Turks* bath very much, and tho' little curious in most of their private Houses, yet are they very sumptuous in their publick Buildings, as their *Chans* or *Caravansara's*, *Moschs*, *Bridges*, and *Baths*, declare.

There are 8 Baths, whereof I had Opportunity to take Notice, during my Stay at *Buda*; 3 towards the East, and South-East Part of the City, in the way leading towards *Constantinople*, and 5 toward the West-end of the Town in the way towards *Old Offen*, and *Strigonium*.

The first is a large open Bath at the Foot of an high rocky Hill, formerly called *Purgatorium*, whereof the People have some odd and scrupulous Apprehensions.

The 2^d is covered with a *Cupola* and stands nigh the same Hill, but more into the Town, and near a Place where they use *Tanning*.

The 3^d is call'd the Bath of the *Green Pillars*, tho' at present they be of a red Colour; and it stands over against the *Caravansara*. The Water is hot, but tolerable without Addition of cold Water. It is impregnated with a petrifying Juice, which discovers it self on the Sides of the Bath upon the Spout and other Places, and maketh a grey Stone; And the Exhalation from the Bath, reverberated by the *Cupola*, by the Irons extended from one Column to another, and by the Capitals of the Pillars, formeth long Stones like *Icicles*, which hang to all the said Places; such as may be observed in many subterraneous *Grotto's*, and particularly in *England*, in *Okey-hole* in *Somersetshire*, and *Pooles-Hole* in *Derbyshire*.

The Water is let out at Night, when the Women have done *Bathing*, who often stay late. The Bath is round, set about with large Pillars, supporting a *Cupola*, which hath Openings to let out the Steam thereof, and yet the whole Room continues to be a hot Stove.

The Baths of the West-end of the Town, are,

1. *Tačalli*, or the Bath of the *Table*; a small Bath covered: The Water white and of a sulphurous Smell.

They

They drink of this as well as bath in it. What they drink, they receive from a Spout bringing the Water into this Place. I delivered a *5 Sols* Piece to a *Turk* bathing in it, to guild for me, which he did in about a Minute, by rubbing it between his Fingers, while the hot Water fell from the Spout upon it.

2. *Barut Degrimene*, or the *Bath of the Powder-Mill*. It rises in an open Pond near the High-way, and mixeth with the fresh Springs, so that the Pond is of a whitish Colour in one Part and clear in the other, as also cold and hot in several Parts. This conveyed cross the High-way into a *Powder-Mill*, becomes useful in making of *Gun-powder*. They conceive here that this Bath communicates with the sulphurous Springs at *Dotis*, many Miles distant.

3. *Cuzzoculige*, the little Bath, or the *Bath of the Saint*; for which Name the *Turks* give a superstitious Reason. 'Tis kept by *Turkish Monks*; the Bath where the Springs arise, is so hot as scarce to be endured; but being let out into another Bathing-place at some Distance, it becomes tolerable and fit for Use. This Water hath neither Colour, Smell, nor Taste, different from common Water, and deposeth a Sediment; only the Sides of the Bath are green, and have a fungous Substance all over.

4. *Kalip*, a very noble Bath, but Part of the Buildings were consumed this Year, (1669) by a great Fire which happen'd in *Buda*, but is by this Time repair'd by the *Turks*. The Water is very hot, not without petrifying Juice in it. The Buildings about it are eight Feet Square, with a noble Bath in the Middle, with a Circle or Trench of Water about it for the better Ornament. On every Side it has a *Nichio*, wherein is a Fountain. In the Middle of the *Anti-chamber*, (where they leave their Cloaths) there is also a fair Stone Bafon, and a Fountain.

5. The *Bath of Velibey*, which hath a strong sulphurous Smell, and a petrifying Juice in it, and is so hot, that to make it tolerable, it requires the Addition of cold Water; this is the noblest Bath of any. The *Antichamber* very large, the Bath-room capacious, and high arched and adorned with *5 Cupola's*: One a very fair one, over the great round Bath in the Middle; and one lesser, over each of the 4 Corners; where are either Baths or Bath-stoves for more private Use: In these the *Turks* take off the Hair of their Bodies by a *Pfilothrum* mixt with Soap; it being not their Custom to have any Hair except on their Beards, and a Lock on the Crown of their Heads. Twelve Pillars support the great *Cupola*, between 8 whereof are Fountains of the hot Water, and between the other are Places to sit down, where the *Barbers* and *Bathmen* attend. And each of these Places have two Cisterns of Free-stone, into which are let in hot Bath-water, and also cold Water, to be mixed and tempered, as every one pleaseth.

Men bath in the Morning, and *Women* in the Afternoon: When any Man intends to bath, having entred the first Room, he finds there diverse *Servants* attending, and furnishing him with a *Cloth* and *Apron*. Then he puts off his Apparel, and having put on the *Apron*, he entereth the 2^d Room, wherein the great Bath is, and sits on the Side of the Bath, or between the *Pillars* nigh a Foun-

Fountain; where the *Barber* strongly rubs him with his Hand opened, stretching out his Arms, and lifting them up; after which the Party batheth. Then if he be a Subject of the *Grand Seignor's* or it be the Custom of his Country, he hath his Head shav'd, and if a young Man, his Beard, except the upper Lip. Next, the Barber rubs his Breast, Back, Arms and Legs with an *Hair-cloth*, while he either sitteth or lieth with his Face downward; then washes his Head with Sope, and after throws cold Water upon him all over his Body, and so the Party walks about in the Steam of the *Bath* for a time.

These *Baths* are made Use of two Ways, either by entring into the Water, or sitting about the *Bath* in the Steam. For the Vapour of the *Bath* makes the whole Room a Stove, and most sweat as long as they stay in it; and some enter not the Water at all, but have it poured upon them, or else only continue in the Steam of the *Bath*, which sufficiently provoketh Sweat.

At Aponum near Padua, by Mr. Doddington, n. 83. p. 4067.

XL. Five Miles from *Padua* are the Waters call'd *Aponensia*, from a Town call'd *Aponum*. They are actually very hot and stinking, and yield a great deal of very fine Salt, of which the *Natives* serve themselves in their ordinary Occasions. The Salt is gather'd after this manner; the *Natives*, after Sunset, stir Pieces of Wood in the Water, and presently the Salt sticks to them, and comes off in small Flakes, exceeding white, and very salt; this never loseth its Savour. The People there, with the same Water, used to wash their Walls, to render them whiter than ordinary; which it doth even whiter than *Lime*. Such *Walls* conserve their *Saltiness* some few Days only, and then become insipid, even tho' they sweat forth a white Excrecence in thin and light Flakes like *Nitre*, many Years after. But that Salt that is collected from the Stones, Gravel and Earth, by which the Rivulets descending from these Baths, do run, is without any Taste of Salt, though there be no Difference in the Form or Colour, from that which is gathered with the wooden Instruments.

Hot Springs and other Mineral Waters in Jamaica, by Sir William Breston, n. 220. p. 226.

XLI. In *Jamaica* there is a very hot Spring of mineral Water, but the Distance and Trouble of getting to it has kept People from trying it till this last Month (*viz. Mar. 1699*) when 2 Persons, the one very much macerated with the *Belly-ach*, and another with the *Pox*, as is supposed, went to it, carry'd *Cloaths*, built a *Hut* to keep them from the Rain and Sun, and both presently by drinking and bathing, found such Ease, that in about 10 Days they returned perfectly cur'd. It comes out of a Rock in a fresh Current, near to a fine Rivulet of good cool Water, but is so hot, they all affirm it soon boils Eggs, some say *Craw-fish*, *Chickens*, and even a *Turkey*; but perhaps this last wants good Confirmation: However it is certain, that near where it comes forth, there is no enduring any Part of the Body, but it takes off the Skin; it cures *Ulcers* and contracted Nerves and Sinews, in a few Days to a Miracle. Coll. *Beckford*, who was given over by the *Physicians*, with Pains in his Bowels very acute, that had worn him out, and another for the *Venereal Disease*, and one for the *Belly-ach*, went up since. Coll. *Beckford* is finely recovered, and the other almost cured of his *Ulcers*; so that the Water is beyond doubt, and many are resorting to it.

It

It has been try'd with *Galls* in my *Sight*, and it makes the *Water* in 24 Hours look only like *Canary*, or *Old Hock*. But we have a fine large River runs by the sides of this Town, which serves all the People for drinking and other Uses, and was by the *Spaniards* call'd *Rio Cobre*, or the *Copper River*; this now our Curiosity has led us to try with *Galls*, and in one Night the *Water* turns to a deep Green, more inclining to Black, deeper colour'd than any *Emerald* I ever saw, which makes me doubt the *Copper Mines* in it are not enough digested, and th' 'tis unwholesome; but were the *Copper* more refined and excellent, it would be a salubrious *Water*. I have also tried several *Water-springs*, and *Rivers* hereabouts, and find them all ting'd with some Metal or other.

2. We have lately discover'd two *hot Springs* in *Jamaica*, one to Windward, which seems sulphurous; the other to *Lee-ward* is very salt, but as I am told, does not partake of *Brimstone*; and both very much magnified for the *Epidemick Diseases* of these Parts, the *Dry Belly-ach*, Pains of the *Nerves*, and *Yaws*.

XLII. Tho' the Particles of *Water* are so minute, that we cannot discern them with our Eyes, yet by feeling, we may distinguish the acute and vigorous Particles of *healing Waters*, from the languid and hurtful Particles of common *Waters*. The *healing Water* will intermingle with their Asperities, such an agreeable *Titillation*, as will invite us to rub in, or press on the cleansing and terfive *Water*; and will all along recompense the Pain of searching the Wound by their active Frictions, with such speedy Reparations, and such indulgent Degrees of *Sanation*, as mitigates the Torment with Store and Variety of Pleasures. Other common *Waters*, even those of some of the purest and almost crystalline Fountains, are most poisonous, encreasing *Tetters*, and fomenting *Ulcers*, with an inward and sullen Painfulness. This dextrous *Water*, by a most favourable *Chirurgery*, searches to the bottom of old and cancerous *Ulcers*, sweeps or shaves away the Roots of *Tetters* and *Cancers*, and appeaseth the unnatural *Rage*; and some of these *healing Waters* are benign, whether we apply them outwardly, or trust them inwardly for the Relief of our *Entrails* and *Vitals*. And by these remarkable *Indications*, and the Effects I have seen succeeding, I have been confirmed of the real Virtue of some of the (so call'd) *Holy Wells*, of oldest Reputation in *England*, and have discovered other *healing Springs*, whose Vertues were not much known, or noted before.

Our Eyes also may be in some Sense good Witnesses of peculiar Figures in the Particles of those *Spring-waters* which are proper for the Eyes. They seem to scour the Eyes, as it were with sharp, but very fine *Gravel*. And by this *Indication*, I have tried and found the Springs which are extraordinary for the Eyes, and perhaps to cleanse *optick Glasses*. About 30 Years ago, in a very hot and drougthy Summer, there was an *Epidemical Distemper* of Men's Eyes and *Eye-lids*; I found it so at *London* and *Westminster*, and almost in every House where I came, as I travell'd Westward on both sides *Severn*; *Verjuice*, or the Juice of *Crabs* was found the best Remedy, and where they knew it not, I gave notice of it, and all that try'd it, confess'd that it was not a very

unpleasant *Application*. Their *Eyes* had a fretting *Itch*, and *Verjuice* prov'd more agreeable than *Vinegar*, or *White Wine*, or any other *Liquor* or *Mixture*. Some such tickling *Pleasure*, but yet more delicate and tender, there is in some *Spring-waters*, which are for the *Eyes* peculiar.

The *Springiness* of *Wool* more than of *Linen*, offers another visible and tangible *Demonstration*, how the stronger and quicker *Springs* of some *Water* more than of other, may conduce more or less to healing; or may be more or less noxious, either inwardly taken or outwardly applied.

I knew one who was shot in his *Heel* with an *Arrow*, which carried with it a very small *Rag* of the *woollen Stocken*: This *Rag* not being found by the *Chirurgeons*, tho' they were then of the best *Note*, the *Wound* became for a *Year* or two incurable; and the *Pain* was so intolerable, that it was thought necessary to cut off his *Foot*. At last by chance the *Rag* was found, and taken away, and then the *Cure* was soon perfected. *Woollen* and *Linen* may have their *Turns* and *Seasons*; the one as a *Mechanical Operation* for *heating* by a close and permanent *Friktion*, the other as a quiet *Lenitive*. Our tender *Skin* can hardly bear the incessant *Springiness* of *Wooll*, in a deep *Wound* we can less endure it. But the *Springs* of some *Waters* may be lined with a softer *Liquor* than the hairy curled *Filaments* of *Wooll*; and hence we may perceive how some *Waters* may by their rolling *Particles* be the greatest *Probes*, and yet the surest *Searchers*, *Cleansers* and *Healers*. And hence also on the contrary, we may see how some *Waters* which cure *Ulcers* and *Cancers* by outward *Application*, may be too busily corrosive and dangerous if taken inwardly.

I think I may note, that generally all the *Springs* in *England* that are of very ancient *Esteem* for *Healing*, and were commonly call'd *Holy Wells*; such as *St. Winifred's Well* in *Flintshire*, of which I never made *Trial*, but it carries the greatest *Fame*, are all very pure, and yield no kind of *Sediment*. In this our *Hot Baths*, and perhaps some few mineral *Springs* are to be excepted. I must yet be more particular.

I know a *Spring*, which the old *People* there call their *Holy Well*, on the side of a low *Hill*, in an arable *Field*, which (besides the *healing Qualities*) hath an extraordinary *Efficacy* in clearing the *Skin* from *Sun-burnings*, and *Freckles*; and addeth as much *Lustre* as agrees with the finer *Art* of concealing *Art*, and with *Modesty*; and after washing 2 or 3 *Mornings* it makes the *Skin* as smooth as *Glass*. It passeth thro' a *Vein* of light *Sand*, if I may call it *Sand*, 'tis more like to some kind of blueish crisped *Marle*, 'tis so light and hollow, as it were freshly working by some *Ferment*; and 'tis full of very small and thin *Laminae*, seeming to be *metalline* and *bright* like the purest *Silver*, but the *Refiners* could not find it to be of any *Value*. I was inquisitive to search it out, whether this *Water* had the *beautifying Property* from the silver-like *Laminae*, or rather gave those *Veins* of the *Earth* that *Tincture* and *Ferment*. Only two *Things* I can affirm: 1. I saw many *Springs* opened in the lower *Grounds*, which seemed in all *Appearance* to run from the same *Head*, and had also the same very bright *Ferment* in their *Passages*, where they were opened, but these had nothing of the same *Property* for

Healing or for *Beautifying*, as I found by many Trials, more than daily, for some Years together. 2. The common Fields adjoining had on their Colds and Fallows, somewhat of the same glittering much faded, but enough to dazle their Eyes that fixed them on it in a bright *Sun-shining*. May not some *subterranean Steam* give the *Tincture*, both to that Vein of Earth thro' which it passed more freely; and also more forcibly to that Spring, by a greater Resort, or by some Advantage it got by the *Ascent* of the Ground? (And we commonly find these *healing Springs* either near the Top, or on the side, or near the Foot of some Hill, or running from the Hill:) And thus the *Steams* reverberated and dashed down by the Motion of the Air, and by the *Weight* of the Atmosphere, may beget the same *metalline Tincture* in the adjacent Fields. This was far enough from yielding Sediment, and it had a pleasing Smoothness, and was very inoffensive to the Stomach; but it search'd the Eyes somewhat smartly, and cleared them speedily, and was generally commended for many *Healings* both inwardly and outwardly, and was every Way much more pleasing than tormenting.

Within 2 Miles of the same, is another of their old *Holy Wells*, on the *vid. sup.* Brow of such another Hill in an arable Field, within half a Mile of the §. xxiv. 4. lofty *Malvern Hill*: This is very kind for the Eyes, and hath also done many Cures upon putrid and foetid Ulcers, which were many Years deplorable for incurable, as I can affirm upon my own Knowledge. I have seen it tried often, and always to good Effect; sometimes considerably wonderful.

Many drink of it, and much extol it for *Healings*: And I never could hear of any that complained of hurt done by it. It was somewhat asperous, but pleasing in malignant Ulcers.

But much greater is the Reputation of the *Holy Wells*, as they call them, on the side of *Malvern Hills*, which Hills divide *Worcestershire* from *Herefordshire*. The higher Spring is peculiar for the Eyes: About a Furlong lower is the *healing Spring*; this cureth many Maladies and Cancers, if applied before the Strength of Nature be overthrown. I have read in the Monuments belonging to the *Hospital* at *Ledbury*, a Town in the Way from *Hereford* to those Springs, that a Bishop some Ages past, endowed that Hospital with Revenues for the Entertainment of distressed Passengers that travelled to those Springs for Relief. 'Tis above 50 Years since I heard a panick Story spread all over the City and Country of *Worcester*, the *Physicians* had poison'd those Wells. I am persuaded, that the ground of this Fable was only this; after more than ordinary Rain, for 1, 2, or 3 Years together, (as it falls sometimes in *England*) some *common Waters*, by a part of the same or some other Channel, do drive to the same Aperture and drown the Excellency of the *healing Water*. In this drougthy Year (1669) we find, that many excellent Springs have lost more than half, and some more than 4 Parts of 5 of the Waters which they did usually afford in the same Seasons of the other moister Years; and the remaining *Waters* have the stronger Efficacy. Of this *Expectation* from long Droughts I formerly advertis'd you. And 'tis now remarkable, that the better *Springs* which are on the Side of Hills, and on the higher Ground, do maintain their *Current* much better than those which

are in the lower Vale. 'Tis so in many Places about us here, when the better Springs had lost 4 Parts of their Current, many of the lower Springs were quite dried up. All these Waters are purely limpid, free from all Sediment, very tersive and searching, most effectual at the *Spring-head*.

I omit many other *healing Waters*, that I may give you a brief Touch of such *mineral, saline, and medicinal Waters*, as I have found, or heard of in our Nighbourhood, namely about *Yeovil* in *Somersetshire*. I lately heard of 2 more *metalline Springs* in *Dorsetshire*, besides that of *Farrington*; perhaps their Virtues and their Fame are increased by this Drought. The *saline Spring* mentioned by Dr. *Higmore* to be at *East-Chenock*, is about 3 Miles hence Westward. In a very drougthy Summer I found it *strong Brine*. But there is a *Salt-spring* of far greater Worth at *Everich*, about 12 Miles hence towards *Shepton-Mallet*. The Pool which yieldeth *vitriolate Salt*, is in *Sock-Dennis*, 3 or 4 Miles from hence Westward. 'Tis not a great Pool, nor above 10 Foot square. Whether the Salt proceedeth from a Spring, or from a Vein of *vitriolate Earth*, I cannot yet determine; but the Mud and Earth about it is as blue as any *Roman Vitriol*. In a long lasting and hard Frost, I sent for a Quart Bottle of the *Water*, and found it very thick and blackish, and it scented intolerably strong, not much unlike Gunpowder newly inflamed. Close adjoining unto this Town of *Yeovil*, were two Springs kind for the Eyes; the one in a Pasture, the other within a Bolt-shoot in a Field.

Vid. inf. §.
XLIV. 2.

Vid. sup. §.
XXX. 3.

The old People prefer that in the Pasture before the other, as they have it from elder Tradition, and their pretended Experience. And at this time, the more commended Spring, which is in the Pasture, and on the side of a rising Ground, runs freely; the other is newly dried up. 'Tis not every slight *gravelling* of the *Eyes* that sufficiently indicates an extraordinary *Eye-water*; many good Springs have a degree of *Tersiveness*; but that which is extraordinary, hath a Friction somewhat permanent, and is in the End gratifying. We have also, close by our Town, a Spring called *Rusty-well*, where it breaks out, and where it first falls, it tingeth the Stones of the Colour of *Rusty Iron*, and it hath the Smell strongly, and seemeth to taste of *Rusty Iron*, yet 'tis as clear as any Water, and I tried it for a Month or more in my Study, putting *Cornish-slate* and Pebbles to it in a Glass, and it gave no Tincture at all to the Stones, nor any Sediment; so that I suspect the Tincture to proceed from some Effluvium mingled with the Water, at first opening; but I confide not much in the single and short Trial I made. Some old Men boast of many great Cures it hath done.

Our Fore-fathers and very old Men, scarce heard of the Name of the Scorbute; 'tis a seasonable Providence, if, since that Disease is become so Epidemical, the Remedy should be so obvious and vulgar, as is pretended to be by such ferruginous Springs.

This breaks out near the foot of a lofty Hill, which continues, with some lesser Falls, about 3 Miles Westward to *Hamden Quarry*, where they dig a hard Freestone of a dark yellow Colour. At *West Camel*, 5 Miles hence, Northward, is a very foetid black Spring, which tingeth Silver black immediately; and I am told, that about 10 Miles hence, more Eastward, near

Wine-Gauntoun, not many Years ago, they digged for *Coal*, where the *Coal-Men* were endangered by a *Fætid Damp*: And when they assayed the *Coal* in the *Fire* it proved very noisom, so that they forsook those *Coal-Mines*. Perhaps it may be serviceable to them that know not how to make an honest Use of *Arsenic* and other *Poisons*.

Here again, with some Timorousness, I propose the Inquiry, whether *subterraneous Steams* might not give the *dark yellow Tincture* to the *Hamden Quarry*, and the Property to this Water of *Rusty-well* for the *Pulvous Coloration*: It cannot be expected, that Materials, differing so much as *Stones* seem to differ from *Water*, when perfectly petrified, should retain the very same Colour, though both received it from the very same *Steams*. The same I propose for the *Blackness* and *Fætidness* of the *Spring* in *West-Camel*, and of the *Coal* near *Wine-Gauntoun*, that both may receive the same *Tincture* and *Odour* from *subterranean Steams*, which may perhaps be of so many Kinds, and Mixtures, as to cause much of the great Diversities of *Metals*, *Minerals*, *Earths*, and *Soils*; and of some minute Differences in the *Colour*, *Taste*, *Odour*, and *Dress* of *Vegetables*; yea and of the *Furrs*, *Hairs*, *Wool*, and other little Varieties in *Animals* (particularly in *Sheep*) in several Places; more immediately in *Vegetables*, and of *Animals* by remoter Circumstances; I will not except the *Ethiopick Hue*, and *Humours* of Men in distant *Climates*, though *Vegetables* and *Animals* do, for the most part, retain their *seminal Properties* in distant *Climates* for many Generations. And perhaps from these *Terrestrial Steams* the *Vegetables* do imperceptibly draw some of their *Salts* and much of their *Nutriments*.

For these *Overtures* I will at present instance no more than thus. The illustrious Mr. *Boyle* hath, methinks, evinced, that the most solid Bodies we know, have their *Atmospheres* of *Steams* and *Exhalations*: And whatever the Materials be, which are under our *Terrene-Crust* towards the Center, whether fluid, flaming, or gross Substances, they must needs hold an Intercourse of *Transpirations*, and mutually operate by their perpetual Agitations, and Whirlings about: And by the *Vulcano's*, frequent in *Japan*, and in several other Places, and by the *Heats* in deepest Mines, and by many other manifest Arguments, it appears, that there are always strong *Steams* ascending towards the Surface of the Earth: And, if their *generative Power*, and other Efficacies were duly examined, and prosecuted to the best Purposes, we might perhaps in Time find them to have a greater Virtue, and more useful for us, than many of the *Constellations* and *Celestial Influences*, which make no small Noise amongst *Astrologers*.

XLIII. Visiting the famous *boiling Fountain* at *Peroul*, not far from *Mont-pelier*, I found the Water to heave, and boil up very furiously in small Bubbles; which manifestly proceeded from a Vapour breaking out of the *Earth*; for upon digging any where near the Ditch, and pouring other *Water* upon the dry place newly dug, I observed in it immediately the same *boiling*, as the exquisite Naturalist Mr. *Ray* has related in his Travels. The like bubbling of Water is also found round about *Peroul*, upon the Sea-shore; and in the *Etang* it self. But when I had take some of the Sand and Earth out

Observations
on boiling
Fountains
and Subter-
raneous
Steams; By
Dr. Tancred
Robinson. n.
169. p. 92.
n. 172. p.
1038.

of

n. 172. p.
1038.

n. 169. p. 923

of the Fountain and Ditch, and put it into Vessels, pouring the same Water upon it, there did not appear the least *Perturbation* or Alteration thereupon; the Superficies of the *Water* continuing very smooth, equal, and quiet. And for further Satisfaction, I sought out, and discovered in several dry Places of the Ground thereabouts, many little *Ventiducts*, Passages or Clefts, where the Steam issued forth; at the Mouths of these Channels or Pipes, placing some light Bodies, as *Feathers*, small thin Pieces of Straws, Leaves, &c. I found them soon removed away. This Vapour upon the Application of a lighted Candle, or Torch, did not flame, or catch the least Fire; as the Fumes running through a boiling Spring near *Wigan* in *Lancashire* do, with which those burning Fountains near *Grenoble* in *Dauphine*, near *Cibinium* or *Hermanstadt* in *Transylvania*, near *Cbermay* a Village in *Switzerland*, in the Canton of *Friburg*, and that not far from *Cracovia* in *Poland*, do agree in many Particulars. Many *Hissing* Springs bubbling at the Top, I have found in *Switzerland*, (the best watered Country that ever I saw) and in many Places near the *Rhine*. The like is related by *Varenius* near *Culma*, and by Dr. *Plot* in *England*. There are other *boyling Waters* of a quite contrary Temper, being actually *Hot* to several Degrees, so as to boyl Eggs, and many other Things put into them; as those near the *Solfatara*, not far from *Naples*, as also upon the Top of Mount *Zebio* in the Duke of *Modena's* Territories, not far from his *Villa* near *Sassalo*; in the Source of the *Emperor's* Bath at *Aken*, in the Country of *Juliers*, and in *Japonia* mentioned by *Varenius*.

From the foregoing History, we may take occasion to reflect a little upon the manifold Variety of *Exhalations* prepared in, and flying out from the vast *Magazines*, and several *Reconditories* below, as to their Qualities and Effects; some being cold and dry, resembling Air or Wind, as those near *Peroul*, and in the *Caverns* of Mountains, especially those of *Aeolus* and other Hills of *Italy*; as also in Mines upon the meeting of *Water*. Others are inflammable, and of a bituminous Nature, though not actually *Warm*, as those near *Wigan* in *Lancashire*. There are also many *Steams* very *Hot*, *Sulphurous*, and *Saline*; more especially those in the natural *Stoves*, *Sweating-vaults*, *Grottos*, *Baths*, and the *Vulcano's* near *Naples*, *Baje*, *Cuma* and *Puzzuolo*, as also in some of the *subterraneous Works* at *Rome*. Others there are of an *Arsenical*, and such like venomous Qualities, as in the *Grotto del Cano*, on the Bank of the *Lago Agrano*; in many Mines, in poisonous Springs and Lakes.

n. 172. p.
1039.
Vid. Inf.
Cap. III.

Now these various Steams meeting with, and running through *Waters*, must cause a great Variety of *Phenomena* and Effects in them. Whether this great Diversity proceeds from the various *Breaths* of the *Pyrites*, and the *Lapis Calcarius*, whilst under their different States, and Changes, or from other Sorts of *Effluvioms*, I dare not determine: But I am apt to believe that there may be Veins of the *Pyrites* near those Places, the *Inflammability* of which *Mineral* hath already been discoursed of, and made very clear by Dr. *Lister*.

An ingenious Author relating the History of a burning Fountain in the *Palatinate* of *Cracovia*, affirms, that upon evaporating the Water, a dark or pitch like Substance may be extracted, which cures the most inveterate Ulcers

cers

cers in a very short Time; and that the Mud it self is very powerful against *Rheumatick* and *Gouty Pains*, *Palsies*, *Scabs*, &c. The Inhabitants of an adjacent Village, drinking much of this Spring, do generally live to 100 or 150 Years, which he attributes to the sanative Virtue of the *Water*.

The *Naptha*, or *Bituminous* Substance floating upon a Spring at *Pitchford* in *Shropshire*, and upon *St. Catharine's Fountain* near *Edinburgh*, had been successfully used in *Ulcerous* and *Cutaneous* Distempers. Many such like Fountains of *Petroleum*, and *Oily Substances*, are to be met with up and down; as in the Island of *Zant*, very plentifully; near *Gabian* in the Road from *Montpelier* to *Beziers* in *Languedock*; in the *Valtaline*, subject to the *Grifons*; at the Foot of Mount *Zebio* in the Dutchy of *Modena*: Not to mention any of the Places written of already by *Varenius*. The Inhabitants living near these Fat Oily Springs, take great care to gather and separate the *Bituminous Substance* from the *Water*, making very considerable Advantages of them, for *Mechanical* and *Medicinal Uses*. I have seen them gather it up with Ladders, and put it into large Filtres, or into great Funnels stopt at the Bottom; or else into Barrels set on one End, which have Spiggots near their Bottoms; when they are full and have stood a while, they open the Spigot or Stoppel to let out the *Water*, and when the Oil or *Bituminous Substance* begins to come, they presently stop it again.

XLIV. 1. The Salt Springs at *Hall* in *Saxony*, are 4, called *Gutiaar*, the Dutch Springs, the *Wettritz*, and the *Hackel-dorn*. The 3 First hold above 7 Parts of Salt, 3 of *Marcasites* and 14 of *Water*. The last holds less, but yields the purest Salt.

Salt Springs at Hall in Saxony, and at Lunenburg; By... n. 8. p. 136.

They are (besides their *Œconomical Use*) employed Medicinally to bath in; and to draw a Spirit out of it, exhibited with good Success against *Venom* and the *Putrifaction* of the *Lungs*, *Liver*, *Reins* and *Spleen*.

The Salt Water at *Lunenburg*, being more greenish than white, and not very *Transparent*, is about the same Nature, and holds with that of *Hall*. It hath a Mixture of Lead with it, whence also it will not be sod in Lead Pans; and if it held no Lead at all, it would not be so good, that Metal being judged to purify the Water; whence all the Salt of *Lunenburg* is preferred before all others, that are made of Salt Springs.

2. I made Trial of that Salt Spring at *East Chenock* in *Somersetshire* (above 20 Miles from the Sea,) which tho' not so salt, by Reason of the late *Rains*; as in *Summer*, yet from a *Wine Quart*, by *Evaporation*, we obtain'd near 80 Grains.

In Somersetshire, By Dr. Highmore n. 56. p. 1130.

3. At *Salt-Water-Haugh* near *Butterby*, about a Mile and a half from *Durham*, in the middle of the River *Weare*, rises a Salt Spring. It is good to be seen and tasted only in the Summer Time, when the Water is discharged all on one side of the Channel: For in Winter, when the River is high it loses its Salt in the fresh Streams, so that they are not perceivable. The Water seems to bubble up equally in all Parts in the Channel, for the Space of 40 Yards in Length, and about 10 in Breadth. The saltest of all the Springs issues out of the Middle of a Rock, the Surface of which was manifestly saltish; and which, in a hot Day, as I was told, would be all covered over with a perfect Salt. I had all the Water laved out of the Place where

In the Bishoprick of Durham; By Mr. Hugh Tod, n. 163. p. 726.

where it seemed to stagnate, and immediately out of the Body of the Rock there bubbled up Water, as salt as the former. It was as high as any Brine can be, and tho' but little in Quantity in Comparison of the fresh River, yet of that Force to give a Brackishness to the Streams a hundred Yards below. Those that have boyl'd this Brine say that it affords a great Quantity of Bay Salt, not so palatable, yet as useful as ordinary Salt is. It tinges all the Stones with a red Colour. The Sea is 8 Miles off, where nearest.

Salt Springs
and Salt-
Making at
Nantwich in
Cheshire; By
Dr. Will.
Jackson, n.
53. p. 1060.
n. 55. p. 1122.
n. 54. p. 1077.

XLV. The Depth of the Salt-springs is in some Places not above 3 or 4 Yards: In *Nantwich*, the Pit is full 7 Years from the footing about the Pit; which is guessed to be the natural Height of the Ground, though the Bank be 6 Foot higher, accidentally raised by Rubbish of long making Salt, or Walling, as they call it. In two Places within our Township the Springs break up so in the Meadows, as to fret away, not only the Grass, but part of the *Turf* of the Meadow, and hath a salt Liquor, oufing as it were out of the Mud, but very gently.

Our Country is generally a low Ground, witness the Name given to it, the *Vale Royal* of *England*; yet it is very full of collicular Eminencies, and various Risings to distinguish it from being all Meadow. The nearest Hills (of those worth calling Hills) is about 7 Miles distant from the Springs; it is steeper but not much higher than *Highbate-Hill*.

We have also a peculiar Sort of Ground in this County and some adjacent Parts, which we call *Mosses*: And they are a kind of moorish boggy Ground, very stringy and fat; which serveth us very well for *Turfs*, cut out like great Bricks and dried in the Sun. And this kind of Ground is so much here, that there are few *Townships* but they have their particular *Mosses*. In these is found much of that Wood we call *Firr Wood*, which serves the Country People for Candles, Fuel, and sometimes for small *Timber Uses*; and this the Vulgar concludes to have lain their since the *Flood*. But generally these *Mosses* seem to be Places undermined by some *subterraneous Streams*; or by the Dissolution of some Matter, that made them equal with the rest of the Ground formerly: In which Conjecture I am confirmed by this, that near a Place of my Lord *Cholmondeley's* called *Bilkely*, about 9 or 10 Years since, not far from one of these *Mosses*, without any Earthquake, a Piece of Ground, about 30 Yards over, fell in with an huge Noise, and great *Qaks* growing on it fell in with it together; which hung first with part of their Heads out, afterwards suddenly sunk down into the Grounds, so as to become invisible: Out of which Pit they drew Brine with a Pitcher tied to a Cart-rope, but could then find no *Bottom* with the Ropes they had there: Since, the Pit is filled up with Water, and now doth not taste salt, but a very little brackish, a very small Rivulet passing through it. The nearest Salt-springs to this place are at *Durtwich* about 3 Miles from it.

Our Springs are about 30 Miles from the Sea; and generally lye all along the River *Weever*: Yet there is an Appearance of the same *Vein* at *Middlewich* nearer the River *Dane* than *Weever*; which notwithstanding seems not to be out of the Line of the *Weever's Stream*; and these lye all near Brooks and in the Meadowish Grounds.

I could observe no Singularity at all in the Plants; for, where the Salt reaches the Surface, it frets away all, as I said before; and upon the *Turf*, near the old decayed Pits, grows the very same, that doth in the remotest Place of the Meadow; only I observe, that where the *Turf* was fretted away, Rushes maintained their Station longest.

The Water is so very cold at the Bottom of the Pit, that when the Briners sometimes go about to cleanse the Pit, they cannot abide in above half an Hour, and in that time they drink much strong Water. There is not any hot Springs (that I can hear of) nearer us, than *Buckston-well*, which is about 30 Miles distant.

Several new Brine Springs have been of late both sought and found; yet none knows of any Shells, but rather a blackish Slutch mixt with the Sand, which infects the whole Spring (like the *Scuttle Fish*) black, when 'tis stirred; else the Water runs very clear.

The Springs are rich or poor in a double Sense; for a Spring may be rich in Salt, but poor in the Quantity of Brine it affords. Thus they have a rich Brine in their chief Pit at *Middlewich*, which yields a full 4th Part of Salt, yet is it so thrifty in its Brine, that the Inhabitants are limited to their Proportions out of it, and their Quantity is supplied out of Pits that afford a weaker Brine. Our Pit at *Nantwich* yields about 1 Pound of Salt for 6 Pound of Brine; but then 'tis always, without any sensible Difference, so plentiful a Spring, that whereas they seldom *Wall*, that *make Salt*, in above 6 Houses at a time, and there are, or should be about 50 *Wich Houses* in the *Town*; this Pit is judged sufficient to supply them all, without falling much lower than a Yard or two at most. And this Advantage would accrue over and above, that such quick Use of the Pit extreamly strengthens the Brine, perhaps to a Degree little less than that of *Middlewich-Pit*: For, I have tryed it my self, that a Quart of Brine, when the Pit had been drawn off 3 or 4 Days first to supply 5 or 6 *Wich-houses*, hath yielded an Ounce and an half more of *Salt*, than at any other time, when it hath had a Rest of a Week or thereabouts.

Mar. 8. 1668. I weighed 2 Pounds of distill'd Water in a Narrow-mouthed Glas-bottle, that I might take an exact Mark for a Quart. This Bottle being filled with our Brine to the very same Mark, weighed (besides the *Tare* of the Bottle) 2 Pound 3 Ounces and 5 Drachms. This was taken up when the *Wich-houses* began to work, so that the Pit was but little drawn. I filled up the Bottle with the same Brine, and it weighed just 3 Drachms more. This Brine boiled away, without any Addition or Clarification, made 5 Ounces and 4 Drachms of Salt. Five Days after, when the Pit had been drawn all that while for the working of the *Wich-houses*, viz. Mar. 13. the same Bottle fill'd to the Quart Mark aforesaid with Brine then taken up, weighed, besides the Bottle, 2 Pounds 4 Ounces and an half: The same time, the Bottle filled, as in the former Experiment, weighed just 2 Pounds and a half, which is 3 Drachms more than the Quarter Mark before; which boiled into *Salt* made 6 Ounces, 6 Drachms and 2 Scruples: Which exceeds

the former Quantity of Salt, 1 Ounce, 4 Drachms and 2 Scruples, through the Brine, exceeded the former in Weight but 4 Drachms.

By which Tryal I confuted also a Tradition, which the Briners have amongst them, viz. that the Brine is strongest at the time of the *Spring-tides*, to wit, at the Full and Change of the Moon. For *Mar. 8.* aforesaid was only one Day past the Full, and then the Brine was weaker than it was the 13th Day, when it was 6 Days past the Full. So that I conclude, there could be no other Reason, than that the much *drawing* makes way for the *Salt-Springs* to come the quicker, and allows the less time for the Admission of *Fresh-Springs*. But 'tis observed by the Briners, that they make more Salt with the same Quantity of Brine in dry than in wet *Seasons*.

Their Manner of *Working* is this; They have formerly boiled their Brine in 6 *leaden Pans* with Wood-fire; upon which Account they all *claim* their Interest in the Pit by the Name of so many 6 *Leads Walling*; by which they each know their Proportion; but, in the Memory of many alive, they changed their 6 *Leads* into 4 *Iron Pans*, something better than a *Yard square*, and about 6 Inches deep, still fitting the Content of these to that of the 6 *Leads*: And of late many have changed the 4 *Iron Pans* into two greater; and some *Wall* but in one; but still the Rulers gage it to their old Proportions.

They use for their *Fewel Pit* Coals, brought out of *Staffordshire*. These *Pans* are set upon *Iron Bars*, and made in on all Sides, very close (that the *Flame* nor *Smoak* break through) with *Clay* and *Bricks*. They first fill their *Pans* with Brine out of the *Pit*; which comes to them in several *wooden Gutters*: Then they put into their *Pans*, amongst their Brine, a certain Mixture, made of about 20 Gallons of Brine, and 2 Quarts of *Calves, Cows*, or chiefly *Sheep's Blood*, mixt into a *Claret Colour*: Of this Mixture they put about 2 Quarts into a *Pan* that holds about 360 Quarts of Brine; this bloody Brine, at the first boyling of the *Pan* brings up a *Scum*, which they are careful to take off with a Skimmer, made with a *wooden Handle* thrust through a long Square of *Wainscot Board*, twice as big as a good square *Trencher*: This they call a *Loot*. Here they continue their Fire as quick as they can, till half the Brine be wasted, and this they call *Boyling upon the fresh*. But when 'tis half boyled away, they fill their *Pans* again with new Brine out of the Ship, (so they call a great *Cistern* by their *Pan's* Sides, into which their Brine runs through the wooden Gutters from the Pump, that stands in the Pit;) then they put into the *Pan* 2 Quarts of the Mixture following: They take a Quart of *Whites* of Eggs, beat them thoroughly with as much Brine, till they are well broken; then mix them with 20 Gallons of Brine, as before was done with the Blood; and thus that which they call the *Whites* is made. As soon as this is in, they boil sharply, till the *second Scum* arise; then they scum it off as before, and boyl very gently till it corn; to procure which, when Part of the Brine is wasted, they put into each *Pan*, of the Content aforesaid, about a Quarter of a Pint of the best and strongest *Ale* they can get; this makes a momentary *Ebullition*, which is soon over, and then they abate their Fires, yet not so, but that they keep it boiling all over, though gently; for the Workmen say, that if they boil fast here, (which they call *Boiling on the Leach*, because they usually

usually all this time lade in their *Leach-brine*, (which is such Brine as runs from their *Salt*, when it is taken up before it hardens) if, I say, they boil fast here, it wastes their *Salt*. After all their *Leach-brine* is in, they boil gently till a kind of Scum come on it like a thin Ice; which is the first Appearance of the *Salt*: Then that sinks, and the *Brine*, every where, gathers into *Corns* at the Bottom to it, which they gently rake together with their *Loots*. I say gently, for which stirring breaks the *Corn*. So they continue till there is but very little Brine left in the *Pan*: then with their *Loots* they take it up, the *Fig. 64.* Brine dropping from it, and throw it into their *Barrows*, which are Cases made with flat cleft Wickers in the Shape almost of a Sugar Loaf, the Bottom uppermost. When the *Barrow* is full, they let it stand so for an Hour and an half in the *Trough*, where it drains out all the *Leach-brine* abovesaid; then they remove it into their *Hot House* behind their Works; made there by 2 *Tunnels* under their *Pans*, carried back for that Purpose. The *Leach-brine*, *Fig. 65.* that runs from the Barrows, they put into the next Boiling, for 'tis to their Advantage, being *Salt* melted, and wanting only hardning.

This Work is performed in 2 Hours in the smaller *Pans*, which are shallower, and generally boil their Brine more away, wherefore their *Salt* will last better, though it does not *granulate* so well, because when the Brine is wasted, the Fire and the Stirring breaks the *Corns*. But this *Salt* weighs heavier, and melts not so soon, and therefore is bought by them that carry it far. But in the greater *Pans*, which are usually deeper, they are about half an Hour longer in boiling; but, because they take their *Salt* out of their Brine, and only harden it in their *Hot House*, it's apter to melt away in a moist Air. Yet of this Sort of *Salt* the bigger the Grain is, the longer it endures, and generally this is the better *granulated* and the clearer, though the other be the whiter. Upon which I rather think, 'tis the taking of the *Salt* out of the Brine before it be wasted, that causes the *granulating* of it, than the Ale to which the Workmen impute it. This Kind measures profitably well, therefore it is much bought by them who buy to sell again.

They never cover their *Pans* at all, during their whole Time of boiling. They have their Houses like Barns open up to the Thatch, with a *Louverhole* or two to vent the Steam of the *Pans*. Possibly Tiles may do better, but no Body is yet so curious as to try; but the Steam is such, that I am confident no Plaister will stick, and the Board will warp, and their Nails will rust so, as quickly to fret in Pieces.

With our *Salt*, both *Beef* and *Bacon* is very well preserved, sweet and good a whole Year together; and I do apprehend this *Salt* to be rather more searching than *French Salt*, because I have often observed, that Meat kept with this *Salt*, shall be more fiery *Salt* to the midst of it, than I have observed when I have eaten powder'd Meat on Ship-board, which was probably done with *French Salt*, I then being on the South side of *England*, and in a *Dutch Vessel*. 'Tis certain *Cheshire* sends yearly much *Bacon* to *London*, which yet had never any Mark of Infamy set upon it; and hang'd *Beef* (which others call *Martinais-beef*) is as good and as frequent in *Cheshire* as in any Place; so that I conclude, that this last is fully effectual for any Use, and as good as any other.

The Sweepings of such *Salt* is constantly shed and scattered about on the Floor, not without taking much of the Dirt, (which occasions its *Grayness*) and is called *Gray-Salt*. This sells not at half the Rate of *White-Salt*, and is only bought up by the poorer Sort of People, and serves them in salting *Bacon*, coarse *Cheese* &c. *Catts* of *Salt* are only made of the worst of *Salt*, when yet wettish from the *Pans*; molded and intermixt with interspersed *Cummin Seed* and *Albes*, and so baked into a hard Lump in the Mouths of their Ovens. The Use of these is only for *Pigeon-houses*. But *Loaves* of *Salt* are the finest of all for Trencher Use. There is no Difference in the boiling of these from the common way of the fine *Salt*; but in the making up, some Care is used: For first they cut their Barrows, they intend for *Salt-Loaves*, with a long Slit from Top to Bottom equally on both Sides; then they tye both Sides together with Cords; then they fill this Barrow with *Salt* boiled as usually, but in the filling are careful to ramm down the *Salt* with the End of some wooden Bar, continuing this till the Barrow be fill'd to their Minds; then placing it speedily in their *Hot House*, there let it stand all the Time of their *Walling*: Wherefore they prepare for their *Loaves* at the Beginning of their Work, that they may have all the Benefit of their *Hot Houses*, and when these begin to slack, they take out the *Loaves*, and untye the Cords that fastened the Barrow, that both Sides of the same may easily open without breaking the Loaf. They then take the Loaf and bake it in an Oven where Household-Bread hath been baked, but now drawn forth. This they do twice or thrice, 'till they see it baked firm enough; and this being placed in a Stove or in a Chimney Corner, and close covered with an Hole of Cloth or Leather, like the Sugar-Loaf-Papers, will keep very white; and when they have Occasion to use any, they shave it off with a Knife (as you do Loaf-Sugar) to fill the Salt-seller.

Explication
of the Fi-
gures.

Fig. 63. The Loot.

Fig. 64. aa, Two Barrows filled with *Salt*. bb, The *Salt* heaped above the Top of the Barrows, and patted down hard. C, The *Leach-Trough*.

Fig. 65. aaaaaa, The *Hot House* between the Wall and the Chimney. bb, two Tunnels. CC, The Chimney-back, into which the Tunnels convey the Smoak. dddd, The 4 *Pans*. E, The Partition-Wall between the *Pans* and the *Hot-House*. ff, The *Fire-places*. gg, *Asb-holes*. hh, The *Hearth* below. ii, The *Descent* to the *Hearth*.

At Droit-
wich in
Worcester-
shire; by Dr.
Tho. Rastel.
n. 142.
p. 1059.

The Country is neither *Plain*, neither hath it any great *Hills*, but many small *Risings*, the greatest *Hills* near us being the *Lichie* within 6 Miles, which some call *Look-high*, supposing it to be the highest Ground in these Parts, because the Springs which rise there, run into the North and South Seas; near to which are *Clent-hills*, about the same Distance. On the other Side the River *Severn* are *Aberly Hills* at about 7 Miles Distance from us. There are many *Salt-springs* about the Town, which is seated by a Brook-side, called *Sakwarp-brook*, which arise both in the *Brook*, and in the Ground near it, though there are but 3 Pits that are made Use of.

Where the Springs are saltest, there grows nothing at all, but by the *Brackish* Ditches there grows *After Atticus* with a pale Flower, which I find no where else with us.

Some

Some of the *Salt-springs* rise on the Top of the Ground, which are not so salt as others. The great *Pit* which is call'd *Upwich Pit* is 3 Foot deep, in which are 3 distinct Springs rising in the Bottom, one comes into the Pit North-west, another North-east, the 3^d South-east, which is the richest both in Quantity and in Quality. They all differ in Saltness, which I can give no exact Account of, it being impossible to separate them, but there will be some Mixture; the Pit is about 10 Foot square, the Sides are made with square Elms jointed in at the full Length, which I suppose is occasioned by the *Saltness* of the Ground which appears to me to have been a *Bog*, the Surface of it is made of Ashes. That it was originally a *Bog*, I am induced to believe, for not many Years since, digging to try the Foundation of a *Seal*, (for so we call our Houses we make Salt in) I thrust a long Staff over Head.

Tho' the *Brine* be colder than the other Water, yet it never freezeth, but the Rain Water that lies upon the Brine in extream hard Frosts, will freeze, but not much.

The *Soil* about the Town, on the lower Side of it, is a black rich Earth, under which 2. or 3 Foot is a stiff gravelly Clay, then Marle. Those that make Wells for fresh Water, if they find Springs in the Marle, they are generally fresh; but if they sink thro' the Marle, they come to a whitish Clay mixed with Gravel, in which the Springs are more or less brackish.

In the great Pit at *Upwich*, we have at one and the same Time, 3 Sorts of *Brine*, which we call by the Names of *First-man*, *Middle-man*, and *Last-man*; these Sorts are of different *Strengths*, the *Brine* is drawn by Pump, so that which is in the Bottom is first pumped out, which is that we call *First-man*, &c. That I might make an exact Trial of the Strength, I made mea Quart that contained 24 Ounces Troy of distill'd Water, which Quart being filled with the first *Brine*, besides the Tare of the Quart weighed 29 Ounces, which made 7 Ounces and 3 Drams of Salt without any Addition; the next Day I weighed the same Salt again, and it weighed 7 Ounces and 6 Drachms; so that 4 Tuns of *Brine*, make above one Tun of Salt. The same Quart filled with *Middle-man*, which is the second Sort of *Brine*, weighed 28 Ounces; I also weighed a Quart of *Brine* as it came immediately out of the Springs, which weighed 28 Ounces, and the 3^d Sort 27 Ounces; so that what the first gets, the last loseth, which doth precipitate as much in 24 Hours, as if it stood a much longer Time.

The Quantity of *Brine* that this Pit yields every 24 Hours is as much as will make 450 Bushels of Salt, which is drawn out twice or three times a Day, for so oft we ordinarily draw, and that as long as the Pump will go.

In the best Pit at *Netherwich*, a Quart of *Brine* weighs 28 Ounces, and an half; this Pit is 18 Foot deep, and 4 Foot broad, and yields as much *Brine* every 24 Hours, as makes about 40 Bushels of Salt; there is but one Spring in the Pit, that comes in 2 Foot and 8 Inches above the Bottom.

The worst Pit at *Netherwich* is of the same Breadth and Depth as the former; a Quart of *Brine* out of which weigheth 27 Ounces, and yields as much *Brine* daily as makes about 30 Bushels of Salt. In this Pit are 3 Springs,

two in the Bottom, and one about 2 Foot higher. These Pits are within 6 Yards of one another.

These Pits are near the *Brook*, the great Pit on the North Side, and about a Quarter of a Mile lower, the 2 lesser Pits on the South-side.

In the great Pit I found no Variation either in Quality or the Strength of the *Brine*, but the Springs in the other Pits are augmented by much Rain, and yield less Salt.

That every Man may know his own Proportion, the *Brine* is divided into *Phats Wallings*; a *Phat Walling* is divided into 12 weaker *Brines*, and every weaker *Brine* is divided into 8 *Burdens*, every *Burden* being a Vessel that contains about 32 Gallons, whereof every one hath 6 *Burdens* of *First-man*, 6 of *Middle-man*, and 6 of *Last-man*, so that every Man hath not only his just Proportion in Quantity, but in Quality also. This *Brine* is carried in Coolers to every Man's Seal, by 8 sworn Men, which we call *Masters* of the *Beachin*, and 4 *Middle-men*, and there put into great Tuns for Use.

The *Fewel*, heretofore used, was all Wood; but since the Wood hath been destroyed by the Iron Works, we use almost all Pit-coals, which are brought to us by Land 13 or 14 Miles.

The *Phats* we boil our *Brine* in are made of *Lead*, cast into a flat Plate at 5 Foot and an half long, and 3 Foot over, and then the Sides and Ends beaten up, and a little raised in the Middle, which are set upon *Brick-work*, which we call *Ovens*, in which is a Grate to make the Fire on, and an Ash-hole, which we call a *Trunk*; in some *Seals* are 6 of these *Pans*, in some 5, and some 4, some 3, some 2. In each of these *Pans* is boiled at a time, as much *Brine* as makes 3 Pecks of white Salt, which we call a *Lade*, and is laded out of the *Pan* with a *Loot*, and put into Barrows, which are set into *Bastals* over Vessels we call *Leash-combs*, that the *Brine* may run from the Salt; which *Brine* we call *Leach*, with which we dress our *Phats*, when the cold *Brine* they are first filled with is something boiled away. In these *Bastals* the Salt stands till it's dry, which is about 4 Hours; then we carry it into *Cribs*, which are Houses boarded on the Bottom and Sides, where 'tis kept till sold, which is sometimes half a Year, or 3 Quarters; in which time, if the *Crib* is good, it will not waste a 12th Part, the Salt itself being of so strong a Body: Whereas in *Cheshire*, they are forced to keep their Salt in Barrows in Stoves to dry it, and make it no faster than they sell.

For clarifying the *Brine*, we use nothing but the *Whites* of *Eggs*, of which we take a Quarter of a *White* and put it into a Gallon or two of *Brine*, which being beaten with one's Hand, lathers as if it were Sope, a small Quantity of which *Froth* put into each *Phat*, raiseth all the Scum, (so that the *White* of an *Egg* will clarify 20 Bushels of Salt) by which Means our Salt is as white as any Thing can be, neither hath it any ill Savour, as that Salt hath, that is clarified with Blood.

For granulating it, we use nothing at all, for the *Brine* is so strong of it self, that unless it be often stirred, it will make Salt as big grain'd as *Bay-Salt*. I have boil'd *Brine* to a Candy-height, and it hath produced Clods of Salt, as clear as the clearest *Allum*, like *Isle of May Salt*, so that we are necessitated to put

put a small Quantity of *Resin* into the *Brine*, to make the Grain of the *Salt* small.

Besides the *White-Salt*, we have another Sort which we call *Clod-Salt*, which grows to the Bottom of the *Phats*, that after the *White-Salt* is laded out, is digged up with a Picker, which is made like a *Mason's Trowel*, pointed with Steel; and put upon a short Staff; this is the strongest Salt I have seen, and is most used for salting *Bacon* and *Neats-Tongues*; it makes the *Bacon* redder than other Salt, and makes the Fat eat firm; if the Swine are fed with *Mast*, it hardens the Fat almost as much as if fed with *Pease*, and salted with white Salt. It is very much used by Countrywomen to put into their *Runnet Pots*, and, as they say, is better for their Cheese. These Clods are used to broil Meat with, being laid on Coals. We account this Salt to be too strong to salt Beef with, it taking away too much of its Sweetness.

A third sort of Salt we have, which we call *Knockings*, which doth candy on the *Stails* of the Barrow, as the *Brine* runs from the Salt, after it is laded out of the *Phats*. This Salt is much used for the same Uses as the *Clod-Salt*, tho' it is not altogether so strong.

A fourth Sort we have, which we call *Scrapings*, that is, a coarse sort of Salt that is mixed with Dross and Dust that cleaves to the Tops of the sides of the *Phats*; this Salt is scraped off the *Phats* when we reach 'em, that is, when we take our *Phats* off the Fires to beat up the Bottom, and is bought by the poor sort of People to salt Meat with.

A fifth sort is *Pigeon-Salt*, which is nothing but the *Brine* running out through the Crack of a *Phat*, and hardens to a Clod on the outside over the Fire.

Lastly, The *Salt-loaves* are the finest of white Salt, the Grain of which is made something finer than ordinary, that it may the better adhere together, which is done by adding a little more *Resin*, and is beaten into the Barrows when it is laded out of the *Phat*.

Our Salt is not so apt to dissolve as *Cheshire Salt*, nor as that Salt that is made by dissolving *Bay-Salt*, and clarifying it, which is called *Salt upon Salt*, which appears by our long keeping it without any Fire.

I believe there cannot be better white Salt than ours, for several Reasons.

1. There is none can be whiter, and consequently more free from Dross.
2. It is the weightiest as I have seen my self, and been informed by others, for the Bags of Salt I have usually seen brought out of *Cheshire* on Horseback, contain 6 Bushels and a half, or 7 Bushels, whereas the best Horses that carry Salt from hence, if they carry it above 5 Miles, carry not above 3 Strike and 3 Pecks, or 4 Strike. A *Winchester Bushel* of our Salt weighs half a hundred Weight, so that it must necessarily follow, the weightiest and driest must needs be best.

3. In the Time of the first *Dutch War*, our Salt was carried down into the West, where they had none before but Foreign Salt, where at first using ours, they complained that it made their Meat too salt, which was because they put as much of ours on their Meat as of others: If so, it must be better than *French Salt*.

4. I have been assured by many that have made Use both of ours, and *Cheshire Salt*, that both for Flesh and white Meat they must lay on more of *Cheshire Salt*, than of ours.

5. It doth preserve all Sorts of Flesh for long Voyages, viz. to *Jamaica*, as well as any, which hath been lately tried.

6. I have seen *Herrings* that have been salted with our Salt in *Ireland*, and brought over to this Town, which have been whiter and better tasted than those salted with *Bay-salt*.

7. It is an ordinary Way of powdering Beef with us, to give it but one salting to keep it the whole Year.

We use not *Iron Pans* as they do in *Cheshire*, and other Places, for we have found upon Trials, that the *Strength* of the Brine doth so corrode, that it quickly wears out those of forged Iron, and breaks those of cast Iron.

The Forma-
tion of Salt
and Sand
from Brine,
by Dr. Rob.
Plot. n. 145.
P. 95.

XLVI. At my Request, two curious Observers, Neighbours to the Brine Pits in *Staffordshire*, to 8 Folds of fine *Holland*, added as many more of finer *Cambrick*, through both which they strained a competent Quantity of the Brine, but found nothing left in this very close Colander, but a little black Dust, which they imputed only to the Foulness of the Water, it being nothing like Sand; for having examin'd the Cloth both with their Fingers and a Microscope, they could feel or see no more of Sand, than if they had percolated the clearest Spring-water; and yet this Brine is found to hold in boiling at least $\frac{1}{2}$ of as much Sand as Salt.

But notwithstanding this *Experiment*, it did not seem to their Apprehensions necessary, that the Sand should be generated in the boiling, but might rather be originally there; for before they strained it, they observed in the Water, by the Help of a Microscope, a great Multitude of very minute Animals, much smaller than those in *Pepper Water*, swimming about in it, together with many small transparent Plates, some of them a little bigger than the *Animalcules*; and some less, but all of a rectangular, oblong Figure, tho' some indeed seemed very near a square, which they found also in the Water, after straining, as thick as before; the Pores or rather Interstices between the Threads of the *Holland* and *Cambrick* appearing in the Microscope 20 times greater than either the *Animalcules* or *Plates*. And these they judged to be the original Particles both of the Salt and Sand, which as the Water evaporates in boiling, they thought might gather together, till they made up such a visible coarse Body, as we see the greater Corns of each are. Wherein they were confirmed in a little time, for observing, with an excellent Microscope, some of the strong Brine, which drops from the Baskets or Barrows when the Salt is first put into them, though at first it looks like clear Water, yet upon a more accurate Observation, it appear'd exceeding full of these oblong Particles, which as they look'd on them, they could sensibly perceive to gather together, and club to make greater Parts, and as the Water dried off from the Glass, to grow far larger and larger, till they appear'd as big, and not much unlike a large siz'd Table Diamond: Which made them guess, that the Sand might be also generated (if

(if I may so say) after the same manner, it appearing to them to be nothing (pardon the Expression) but insipid Salt, composed of Parts not so sharp pointed as the other, but rounder and blunter angled, and consequently not so pungent on the Tongue.

Upon this Suggestion, having some of the *Sand* by me, I endeavour'd to dissolve it in fair Water, to see whether I could reduce it again into its former State, but without Success; its Parts being so inseparably fixt, that they would by no means dissolve. I also tried the *Salt*, which tho' it dissolved, yet would not render it self again into the Plates. Whereof sending an Account to my Friends in *Staffordshire*, they were pleas'd also to make a further Trial of dissolving the *Sand* separated from the *Salt* in boiling, which tho' they confess'd they could not do to any considerable Quantity, yet they found, that after the straining, it was not so heavy by a great deal as before, the Water that came from it being very clear; which made them believe, that it did dissolve in some measure, unless, as is very probable, there were in the *Sand* some Particles of *Salt*, which, upon Dissolution, were separated from it, and so rendred it lighter: Nevertheless they did not doubt, but a great part of the *Sand* might also be dissolved, tho' perhaps no great Quantity in *Pump-water*, in which it seems they tried it.

One of the afore said Gentlemen casually looking upon some of the *Salt* made at those Pits, before it was dried and beaten small, observed that many of the larger Corns were of the same Shape to the naked Eye, as the minute ones appeared in the Microscope, and that they were visibly made up of a great Number of small Plates, shooting up from a quadrangular oblong Base into a very obtuse Pyramid, hollowed within.

XLVII. At *Northwich* in *Cheshire*, upon the *Weever*, in 4 Pits is great Plenty of Brine; it stinks of *Sulphur* apparently in all the Pits; it becomes atramentous with Galls.

Observations
on the
Midland
Salt-springs
by Dr. Lister.
n. 156 p. 489.

Here are used *Sand-pans*, which are let down in the Corners of the great Iron Boilers, before the Salt shoots into Grains, and these catch the *Sand*. Besides there are thick Stone Flakes raised from the Bottom of the said Iron Boilers once a Week.

N. B. Within half a Mile of these *Brine-pits* at *Marberry*, a salt Rock was found by the Augur in boring for Coals.

Vid. Inf.
Cap. 3.

Here, and at *Middlewich*, also at *Nantwich*, and all along the River *Weever*, which are places many Miles distant, sink on either side of the River, and you will scarce miss of Brine, as I was credibly inform'd by the most knowing Men in that particular: But yet it proves a Venture, whether the Brine will be strong enough to boil and turn to Account; and for this reason, their Pits sometimes fail them, to their great Loss, (as they shewed me one which had been wrought to very great Profit) by a small sweet Spring breaking into it, and sometimes the River *Weever* it self does them this Mischief.

At *Nantwich* upon the same River, is one very large Brine-pit. This Water also plainly smells as it were corrupted, or like Sulphur, but notoriously upon a few Days Forbearance of the Pit. It becomes atramentous with Galls. It yields a white Sand or Stone, adhering in the manner of thin Scales, to the Bottom of the iron Pans, in which the Brine is boiled.

Weston Brine-Pit near *Stafford*. This Water in the Pit stinks like rotten Eggs: With Galls it becomes suddenly atramentous. It purges and vomits violently, and that drunk in a small Quantity. Here are used *Sand-pans* to catch the white Sand, and there are Flakes of Stone also raised from the Bottom of the great Iron Boilers.

Droitwich in *Worcestershire*: The upper *Wych* or *Brine-pit* is very neatly kept, and exceedingly drawn, because there are so many Proprietors, and but a small Pit, comparatively to those which have been named above.

Mr. J. Collins, J. & Fish.

Here the Salt is boiled in small leaden Pans, and there is not the least Grain of Sand at any time, which either falls before the graining of the Salt, or that adheres to the Pans Bottoms, notwithstanding what hath been said to the contrary: And therefore this Brine being naturally without Sand, it must yield the more wholesome Salt.

The lower Pit at the *Netherwych* in the same Town, hath but one Proprietor, as I remember, and therefore is less drawn, but yet is constantly and well wrought. Here is also no News or Knowledge of any Sand at all. The Water of these Pits stink like rotten Eggs, especially after Sunday's Rest: And (*N. B.*) will, if Flesh be pickled in them, make it stink in 12 Hours. And yet the Salt that is boiled out of these Pits, is accounted the very best Island Salt of *England*, and I believe as good as any in the World.

I observed in a Ditch over against the *Nether Wych-house*, the Water standing with a white Scum, as at the *Sulphur-Springs* in *Yorkshire*.

I shall add by way of Corollary,

1. That all our *Yorkshire Wells* call'd *Sulphur Springs*, (which are many) are no other than so many *Brine-pits*, and if they were well drawn and wrought, would be as little offensive in Smell.

2. That this Stone-powder is also to be found adhering to the Iron Pans, where the Sea-water is boiled into Salt, as it is at *Shields*, in the Bishoprick of *Durham*; but I do not remember it to be in the Lead-pans at *Medop* and *Milthrop* in *Lancashire*, where the Sea-sands are lixiviated, and that *Lixivium* boiled into Salt; nor is it remembered in the Account given of the making of *Sea-Salt* by *Insolation*: Nor could I observe it in the least, in distilling of Sea-water in a Glass Still, or in the *Yorkshire Stinking Wells*; of which a good Quantity is yearly made for medical Use, or rather Curiosity, to vend to Strangers.

Vid. Infr. S. XLVII.

N. B. This Sand falls to the Bottom before the Salt-Grains.

This is so also in all other *Mineral Salts*, whose Brines being boiled, ever let go first this stony Part: The *Oker* falls in Powder upon the first boiling, but the *Lapis Calcarius* rises in Flakes like Wafers, which yet falls in Powder by Frost, as we have elsewhere observed.

+

S S A

3. This

3. This Stone-powder irrigated with fair Water, and kept moist, does yield an immature Salt of an uncommon Figure: Which I have described at large and figured. De Font.
Med. Angl.

4. Notwithstanding the great Affinity betwixt the Salt of the Midland Brine-pits, which is common Salt, and the Sea-Salt: I must not omit (amongst others) a specifick Difference, which is by me (that I know of) now first published, and which, in my Opinion, makes the Sea-water a Water of its own kind: And also shews, that none of the Productions of incinerated Plants are truly a *Marine-Salt*.

The Angles of Crystals of common Salt, boil'd out of the *Midland Brine-pits*; as also of Salt Gem, or Rock-Salt, which I take to be one and the same, are entire, and so are all those lixiviated marine Salts, so called and described by Dr. Grew. But the *Angles* of the Crystals of true *Sea-Salt*, are ever some of them cut off into *Triangular Planes*, at least on one of the Sides. And this I learnt by suffering a Bottle of *Sea-water*, taken up upon the Coast at *Scarborough*, where no River near enters it, to evaporate leisurely placed in the Shade, after it had been half boiled away; and here all the Crystals (which are many, and of different Magnitudes) did yet agree in a like Figure, as is described; and I do not doubt but it will succeed with any *Sea-water*.

XLVIII. *AAA*, is the *Sea*.

11, The Entry, by which the *Sea-water* passes into *B, B*.

BB, The first Receptacle; in which the Water maketh 3 Turnings, as you see, and is 10 Inches deep.

22, The Opening, by which the first and 2^d Receptacle have Communication one with another.

EEF, The 3^d receptacle which is properly call'd the *Marish*.

dddd. Is a Channel very narrow, through which the Water must pass, before it enters out of the 2^d Receptacle into the 3^d.

33, Is the Opening, by which the Water runs out of the 2^d into the 3^d Receptacle.

The *Pricks* you see in the Water, throughout the whole Scheme, do mark the Course and Turnings which the Water is forced to make, before it comes to *hhhhh*, which are the Places where the Salt is made.

hhhhh, Are the Beds of the *Marish*, where the Salt is made; and in them the Water must not be above an Inch and an half deep. Each of these *Beds* is 15 Foot long, and 14 Foot large.

99999, Are the little Channels between the Beds.

88888, Are the Apertures, by which the Beds receive the *Sea-water* after many Windings and Turnings.

When it rains, the *Openings* 22, 33, are stopp'd to hinder the Water from running into the *Marish*. Unless it rain much, the Rain-water doth little hurt to the *Marish*; the Heat of the Sun sufficiently exhaling it, if it be not above an Inch high; only if it have rained very plentifully that Day, no Salt is drawn for the 3 or 4 next Days. But if it rain 5 or 6 Days, the People

A a a z

are

*The Way of
making Salt
in France, by
Dr.
n. 51. p. 142
Fig. 60.*

are then necessitated to empty all the Water of the Beds by a peculiar Channel, which cannot be opened but when it is low Water. But 'tis very seldom that it rains so long as to constrain Men to empty those Beds.

The hottest Years make the most Salt, and in the hottest Part of the *Summer* there is Salt made even during Night. Less Salt is made in calm, than in windy Weather.

The West and North-west Winds are the best for this Purpose.

Our Country People draw the Salt every other Day, and every Time more than an hundred Pound Weight of Salt.

The *Instruments* used to draw the Salt, have many small Holes to let the Water pass, and to retain nothing but the Salt.

The reddish Earth in *Marishes* make the Salt more gray, the blewish, more white: Besides, if you let run in a little more Water than you ought, the Salt becomes then more white, but then it yields not so much. Generally all the *Marishes* require a fat Earth, neither spongy nor sandy.

The *Salt-man* who draw the Salt, must be very dextrous. In this *Isle* of *Rhee* there are that draw very dark Salt, and others that draw it as white as Snow; and so it is in *Xaintonge*. Chiefly, care is to be taken that the *Earth* at the Bottom of the Beds mingle not with the Salt.

The Salt we use at our Tables is perfectly white, being the *Cream* (or that Salt which is formed on the Top of the Water) drawn 4 or 5 Hours before the Salt is to be drawn. The Grains of it are smaller than of the other. Generally the Salt of *Xaintonge* is somewhat whiter than ours. The Bigness of our Salt is of the size of a Pepper Grain, and of a cubical Shape.

The *Marishes* are preferred from one Year to another, by overflowing them a Foot high.

The Timber of the *Marishes*, if it be of good Oak, keeps near 30 Years, but there is used but little Wood, all the *Ditches* and *Apertures* being done with Stones.

XLIX. At *Wire-water* in *Lancashire*, Salt is gathered out of Heaps of Sand along the Sea-side in many Places: Upon which Sand (saith *Speed*) the People pour Water, until it gets a saltish Humour, which they afterwards boil with Turfs, till it become white Salt.

In Lancashire
by Dr. J.
Beal, n. 103.
p. 51.

The Water of the Brine-pits in Summer-time, when the Brine is strongest, being cast in any place where it may be soon dried by the Sun, and where we would have *Pigeons* resort, does please them well; so will any refuse Brine being boiled up to a Consistence. But I know not whether such Brine, taken from powder'd Flesh, will be kind for Sheep.

In Germany.
by ... n. 7.
p. 128.

L. An observing Gentleman writes out of *Germany*, That no salt Water which contains any Metal with it, can well be sodden to Salt in a Vessel of the same Metal which it self contains, except *Vitriol* in *Copper Vessels*.

He adds, that to separate Salt from Salt-water without Fire, if you take a Vessel of *Wax*, hollow within and every where tight, and plunge it into the Sea, or into other salt Water, there will be made such a Separation, that the Vessel shall be full of sweet Water, the Salt staying behind; but though this Water have no saltish Taste, yet he saith, there will be found a Salt in

the

the Essay, which is the *Spirit of Salt*, subtil enough with the Water to penetrate the Wax.

LI. We have seen here (at *Leyden*) a Maid, of about 13 Years of Age, which from the Time that she was but 6 Years old, and began to be about her Mother in the Kitchen, would, as often as she was bid to bring her Salt, or could else come at it, fill her Pockets therewith, and eat it, as other Children do Sugar; whence she was so dried up, and grown so stiff, that she could not stir her Limbs, and was thereby starved to Death.

*The Joynts of
a Girl made
stiff by eating
Salt;
By.....
n. 8. p. 138.*

LII. *Papers of less general Use*, omitted.

1. **S**ome Objections of the *Fr. Journalist* to the *Engines* for drawing up Water from the Bottom of the Sea, and for sounding the greatest Depths without a Line, answer'd by Mr. Oldenburg. n. 13. p. 228.
2. Inquiries concerning the Sea; by Mr. Rob. Boyle. n. 18. p. 315.
3. Inquiries and Directions concerning Tides; proposed by Dr. J. Wallis. n. 17. p. 297.
4. Patterns of Tables proposed to be made for observing of Tides, by Sir Rob. Moray. n. 18. p. 311.
5. Quæries about Tides in China and the E. Indies; by Mr. Edm. Halley. n. 162. p. 685.
6. Several Engagements for observing of Tides. n. 21. p. 678.
7. A correct Tide-Table, shewing the true Time of High-Water at London Bridge to every Day in the Year 1682; by Mr. Flamsteed. Phil. Cal. n. 4. p. 102.
8. The same, for the Year 1683. n. 143. p. 10.
9. The same, for the Year 1684. n. 153. p. 458.
10. The same, for the Year 1685. n. 166. p. 821.
11. The same, for the Year 1686. n. 177. p. 1226.
11. The same, for the Year 1687. n. 185. p. 232.
13. The same, for the Year 1688. n. 191. p. 428.
14. Objections from *Vossius*, *De Motu Marium & Ventorum*, and from *Gassendus*, *De Æstu Maris*, to Dr. Wallis's Theory of Tides, answer'd; by Dr. Wallis. n. 16. p. 286.
15. Quæries and Conjectures concerning Mineral Waters; by Dr. Dan. Foot. n. 52. p. 1054.
16. An Inquiry concerning the Causes of Mineral Springs proposed; by Dr. J. Beal. n. 56. p. 1132.
17. Some Quæries whereby to examine Mineral Waters; by Sir W. Petty. n. 166. p. 802.
18. Inquiries about the Salt-Springs in *Worcestershire* and *Cheshire*; by Dr. J. Beal. n. 20. p. 359.
19. Inquiries and Suggestions concerning Salt for Domestic Uses; by Dr. J. Beal. n. 303. p. 48.

LIII. *Accounts, Refutations, and Emendations of Books*, omitted.

1. **I**S. *Vossius de Motu Marium & Ventorum*.
2. *Gassendus de Æstu Maris*.

n. 16. p. 286.
ib. p. 287.

3. De

- ...167.p.862. 3. *De Origine Fontium Tentamen Philosophicum*, in Prælectione habita coram Societate Philosophica nuper Oxoniæ instituta ad Scientiam Naturalem promovendam. Per Rob. Plot, L. L. D. Oxon. 1685. in 8^{vo}.
- n.233.p.734 4. *De Fontium Mutinensium admiranda Scaturigine*, Tractatus Physico-Hydrostaticus Bernardini Rammazzini, in Mutinensi Lycæo Med. Prof. Mutinæ. 1691. in 4^{to}. Translated into English, and illustrated with many curious Remarks and Experiments by the Author. and Translator, Dr. Rob. St. Clair. Lond. 1697. in 8^{vo}.
- n.51.p.1038. 5. Dr. Tobias Whitaker of drinking Mineral Waters, 1634.
- n.42.p.850. 6. *Hydrologia Chymica*, or the Chymical Anatomy of the Scarborough and other Spaws in Yorkshire, &c. by W. Sympson. Lond. 1668. in 8^{vo}.
- n.49.p.999. 7. An Answer to *Hydrologia Chymica* of Will. Sympson; by Rob. Wittie. M. D. Lond. 1669. in 8^{vo}. Besides the Account of this Book, there is a Correction of a Mistake of the Printer in the 3^d Page.
- n.51.p.1038. 8. Some Reflections made on this Account of Dr. Wittie's Answer to *Hydrologia Chymica*; by Dr. Dan. Foot.
- n.57.p.1154. Dr. Foot's Reflections consider'd; by Dr. J. Beal.
- n.56.p.1128. Some Considerations relating to Dr. Wittie's Defence of Scarborough Spaw; by Dr. Highmore.
- n.60.p.1074. A Discourse of Dr. Rob. Wittie, relating to the Notes and Queries of Dr. Foot, and to those of Dr. Highmore, concerning Mineral Waters, and Extracts made out of them.
- n.62.p.2032. 8. A Vindication of *Hydrologia Chymica*, by Will. Sympson. M. D. Lond. 1670.
- n.85.p.5019. 9. Scarborough Spaw spagyrically anatomiz'd. An. 1670; and a New Year's Gift for Dr. Wittie. Lond. 1671. both in 12^{mo}. by Geo. Tonstal. M. D.
- n.144.p.59. 10. 1. M. Lister, M. D. *De Fontibus Medicatis Angliæ*; Exercitatio nova & Prior. Eboraci 1682. in 8^{vo}.
- n.518.p.579. 2. M. Lister, M. D. *De Fontibus Medicatis Angliæ*; Exercitatio altera Lond. 1684. in 8^{vo}.
- n.172. 11. Short Memoirs for the Natural Experimental History of Mineral Waters, by the Honourable Rob. Boyle. Lond. 1685. in 8^{vo}.
- P. 1063.
- n.206. 12. Tentamen Philosophicum de Aquis Mineralibus, &c. Auth. Carolo Leigh, M. D. Lond. 1694. in 8^{vo}. Dr. Cay here objects many Things to that Author's Observations.
- P. 1003.
- n.245.p.368. 13. The Natural History of the Chalybeate and Purging Waters of England, with their particular Essays and Uses, &c. with Observations on the Bath-Waters in Somersetshire, by Benj. Allen, M. D. Lond. 1699.
- n.251.p.146.
- n.125.p.612 14. Observations sur les Eaux Minerales des plusieurs Provinces de France, faites en l'Academie Royale des Sciences, en l'Anne 1670. & 1671. par le Sieur du Clos. A Paris. 1675. in 12^{mo}.
- n.125.p.573. 15. *Bathoniensium & Aquisgranensium Thermarum Comparatio*, variis adjunctis illustrata, a R. P. Lond. 1676. in 8^{vo}.

C H A P. III.

Mineralogy.

I. 1. **T**HE *Mine* or *Adit* is to be made 7 or 8 Foot high, which though it seems to make more Work downwards, yet will be found necessary for making the better Dispatch by rendring the *Invention* more effectual.

There is a Tool of Iron well steeled at the End, which cuts the Rock, (of the Shape shewed by the *Figure* annexed) 20 or 22 Inches long or more, and some 2½ Inches Diameter at the steeled End, the rest being somewhat more slender. The steeled End is so shaped, as makes it most apt to pierce the Rock, the Angles at that End being still to be made the more obtuse, the harder the Rock is. This Tool is to be first held by the hand in the middle between the Sides of the Rock that is to be cut, but as near the Bottom as may be. The Tool being placed, is to be struck upon with a Hammer, the heavier the better, either suspended by a Shaft turning upon a Pin, or otherwise, so soon as one Man may manage the Hammer, while another holds the Tool or *Piercer*. If it be hung in a Frame, or other convenient way, he that manageth it hath no more to do but to pull it up at first as high as he can, and let it fall again by its own Weight, the Motion being so directed as to be sure to hit the *Piercer* right. After the Stroke of the Hammer, he that holds the *Piercer*, is to turn it a little on its Point, so that the Edges or Angles at the Point may all strike upon a new Place, and so it must still be shifted after every Stroke, by which means small Chips will at every Stroke be broken off, which must from time to time be taken out, as need requires. And thus the Work must be continued, till the Hole be 18 or 20 Inches deep, the deeper the better. This Hole being made deep as is required, and kept as straight and smooth in the sides as is possible, there is then a kind of double Wedge to be made, and fitted exactly for it, the Shape whereof is to be seen in the annexed Figure.

This double Wedge being 12 or 13 Inches long, each piece of it, and so made as being placed in their due Position, they may make up a *Cylinder*, cut *Diagonal wise*. The 2 Flat-sides, that are contiguous, are to be greased or oiled, that the one may slip the more easily upon the other, and one of them, which is to be uppermost, having at the great End a hollow Crease cut into it round about, for fastning a Cartridge full of *Gun-powder* to it with a Thread, the round End of the Wedge being pared as much as the Thickness of the Paper or Past-board that holds the *Powder* needs, to make the Out-side thereof even with the rest of the Wedge. This Wedge must have a Hole drilled through the longest Side of it, to be filled with *priming Powder*, for firing of the *Powder* in the *Cartridge*: Which needs have no more than half a Pound of *Powder*, though upon Occasion a greater Quantity may be used, as shall be found requisite.

Then this Wedge being first thrust into the Hole with the *Cartridge*, the Round-side, where the *priming Hole* is, being uppermost, the other Wedge is to be thrust in, home to the due Position, Care being taken that they fit the

To Break
hard Rocks
by M. Du
Rois. n. 5.
p. 82.

Fig. 67.

Fig. 68.

the Hole in the Rock as exactly as may be. Then the End of the lower Wedge being about an Inch longer than that of the upper, outwardly and flattend, *priming Powder* is to be laid upon it, and a piece of burning *Match*, or Thread dipt in Brimstone, or other such prepared combustible Matter, fastned to it, that may burn so long before it fire the *Powder*, as he that orders it may have Time enough to retire quite out of the Pit or *Adit*, having first plac'd a piece of Wood or Iron so, as one End thereof being set against the End of the lower Wedge, and the other against the Side-wall, so as it cannot slip. Which being done, and the Man retired, when the *Powder* comes to take Fire, it will first drive out the uppermost Wedge as far as it will go; but the slaunting Figure of it being so made, as the farther it goes backward the thicker it grows, till at last it can go no farther, then the Fire tears the Rock to get forth, and so cracks and breaks it all about, that at one time a vast deal of it will either be quite blown out, or so crack'd and broken as will make it easy to be remov'd.

By Mr. Beaumont n. 167.
p. 845.

2. A considerable *Adventurer* in the *Lead-Mines* on *Mendipp-Hills* acquaints me, that the *Miners* there, within these 12 Months, had got a new Way of

Fig. 69. *Cleaving Rocks with Gun-powder.*

The *Borer* is made of Iron, and is 2 Foot 2 Inches in length: It is an Inch square at the steeled end from *a* to *b*, and somewhat less in the other part. The use of this Instrument is to make a Hole in the Rock deep enough to receive the *Powder*. The Gun is 6 Inches in length, $1\frac{1}{4}$ Diameter, and has a Hole drilled through it to receive the *priming Powder*. When a Hole is

Fig. 70. made with the *Borer* somewhat deeper than the Length of the *Gun*, they dry it with a Rag, and put into it about 2 or 3 Ounces of *Powder*, over which they put a thin Paper, and on it place the *Gun*, which they bind firmly into the Hole, by driving in against the flat Side of the upper Part of it a little Iron Wedge 4 Inches in length, by the *Miners* called a *Quinnet*.

Fig. 71. When this is done, they pass down a Wire through the Hole drilled in the *Gun*, and pierce the Paper which covers the *Powder*, and then they *prime* the *Gun*, and lay a *Train*, and go up out of the Work, before the *Powder* comes to take Fire. The *Paper* is put at first over the *Powder*, lest when the *Gun* and *Quinnet* are driven down, the Tools may strike Fire and kindle the *Powder*.

These *Instruments* are of great Advantage to *Miners*; for as soon as a Man has fired his *Powder* and broken the Rock, he may presently go to Work again; whereas after a Fire is laid in a Shaft, a Man can scarce go to work in 24 Hours, the Rocks being too hot to suffer him.

Okey-Hole,
and some
other subter-
raneous Ca-
verns in
*Mendipp-
Hill*; by Mr.
J. Beaumont.
Ph. Col. n. 2.
P. 1.

II. 1. On the South side of *Mendipp-Hills* within a Mile of *Wells*, is a famous *Grotto*, known by the Name of *Okey-hole*, much resorted to by Travellers: The Entrance of it is in the Fall of those Hills, which is there all beset with Rocks, having near it a precipitous Descent about 10 or 12 Fathom deep; at the Bottom of which there always issues from the Rock a considerable Current of Waters. The naked Rock above the Entrance, shew themselves for about 30 Fathom in Height; though the whole Ascent of the Hill above it is about a Mile, and is very steep. As

As you pass into this *Vault*, you go upon a Level; but advancing further into it, you find the Way rocky and uneven, sometimes ascending, and sometimes descending, as generally in all *Caverns*. The Roof of it, in the highest Part, is about 8 Fathom from the Floor; and in some Places it is so low, that a Man must stoop to pass. The Wideness of it is also various; in some Parts it is about 5 or 6 Fathom; in others, not above a Fathom or two: it extends itself in Length about 200 Yards. People talk much of several Stones there, resembling Men, and other Things; but they are only Lumps of common *Sparr*, without any regular *Figures*.

At the farthest Part of this *Cavern*, there rises a good Stream of *Water*, large enough to drive a Mill, which passes all along one side of the *Cavern*, and at length glides down about 6 or 8 Fathom betwixt the Rocks; and then pressing through the Clefs of them, discharges itself into a Valley.

This *River* within the *Cavern*, is well stored with *Eels*, and hath some *Trouts* in it, which must of necessity have been engendred there, and not come from without, there being so great a Fall, as I have mention'd, near the Entrance. It happen'd some few Years since, that many Cattle, which fed in Pastures, through which this River passes, died suddenly after a Flood; the Cause of it being supposed to be, that these Waters had a Communication under Ground in *Mendipp-Hills*, with certain Waters which came from the Washing of *Lead Ore* in the *Minery Ponds*, which are two Miles and a half distant from this *Cavern*, and were convey'd into the Ground by a *Swallow*, near the Place where the *Ore* was wash'd; which *Swallow* has since been caus'd to be damm'd up.

In a dry Summer, I have seen a good Number of *Frogs* all along this *Cavern*, even to the farthest Part of it, and other little *Animals* in some small *Cisterns* of *Water* there.

Before you come to the Middle of this *Vault*, you will find a Bed of very fine Sand, which is much sent for by Artists to cast *Metals* in.

On the Roof of it, at certain Places, hang Multitudes of *Batts*: and indeed we generally find them in all *Caverns*, whose Entrance is upon a level, or somewhat ascending or descending, so it be not perpendicularly; and even in these, if the Passage into them be not narrow, and of a considerable Height or Depth.

2. About 5 Miles from this, on the South-west Part of *Mendipp-Hills*, near a Place called *Chedder*, lies another *Cavern*, into which you must ascend about 15 Fathoms on the Rocks. This *Cavern* is not of so large an Extent as the former; there is no Current of *Water*, nor does *Water* drop so freely from the Roof, as generally in other *Caverns*; wherefore the *Sparrs* appear not of so lively Colours, as commonly elsewhere.

3. These two *Caverns* have no Communication with *Mines*: But we generally observe, that wheresoever *Mines* of *Lead-Ore* are, there are *Caverns* belonging to them, which are of a various Nature and Situation. The most considerable of these *Vaults*, I have known on *Mendipp-Hills*, is on the most northerly Part of them, in a Hill call'd *Lamb*, lying above the Parish of *Harptry*. Much *Ore* has been formerly raised on this Hill; and being told,

some Years since, that a very great *Vault* was there discover'd, I took 6 *Miners* with me, and went to see it. First we descended a perpendicular *Shaft* about 10 Fathom, then we came into a *Leading Vault*, which extends it self in Length about 40 Fathom; it runs not upon a Level, but descending, so that when you come to the End of it, you are 23 Fathom deep, by a Perpendicular Line. The Floor of it is full of loose Rocks; its Roof is firmly *Vaulted* with Lime-stone Rocks, having Flowers of all Colours hanging from them, which present a most beautiful Object to the Eye, being always kept moist by the distilling Waters. In some parts the Roof is about 5 Fathom in height, in others so low, that a Man has much ado to pass by Creeping. The Wideness of it, for the most part, is about 3 Fathoms. This *Cavern* crosses many *Veins* of *Ore* in its running, and much *Ore* has been thence raised. About the Middle of this *Cavern*, on the East side, lies a narrow Passage into another *Cavern*, which runs betwixt 40 and 50 Fathom in length. At the end of the *First Cavern* a *Vast Cavern* opens it self. I fastened a Cord about me, and ordered the *Miners* to let me down: And upon the Descent of 12 or 14 Fathom I came to the Bottom. This *Cavern* is about 60 Fathom in the *Circumference*, above 20 Fathom in height, and about 15 in length; it runs along after the *Rakes*, and not *Crossing* them as the leading *Vault* does. I afterwards caused *Miners* to drive forward in the Breast of this *Cavern*, which terminates it to the West, and after they had driven about 10 Fathom, they happened into another *Cavern*, whose Roof is about 8 Fathom, and in some parts 10 or 12 in height, and runs in Length about 100 Fathom.

The Frequency of these *Caverns* on those Hills may be easily guest ar, by the Frequency of *Swallow Pits* which occur there in all Parts, and are made by the falling in of the Roofs of *Caverns*; some of these *Pits* being of a large Extent and very deep; and sometimes our *Miners* sinking in the bottom of those *Swallows*, have found *Oaks* 15 Fathom deep in the Earth.

Elden-Hole in Darbyshire; By Dr. Plot, ib. p. 7. III. Dr. Plot has learnt by an Inquisitive Gentleman, who purposely made Tryal of it, that one of those *Caverns* in the *Peake* in *Darbyshire*, hath been sounded in depth by a Perpendicular Plum-Line, no less than *Eight and Twenty Hundred Feet*, without meeting with the Bottom, or Water; and yet the Mouth of this *Cavern* at the Top, is not above 40 Yards over.

Pen-Park-Hole in Gloucestershire; By Capt. Sturmy, n. 143. p. 2. IV. 1. Upon the 2d of July 1699, I descended by Ropes affix'd at the top of an Old *Lead-Ore Pit*, 4 Fathoms almost Perpendicular, and from thence 3 Fathoms more obliquely, between two great Rocks, where I found the Mouth of this spacious Place, from which a *Mine-Man* and my self lower'd ourselves by Ropes 25 Fathoms perpendicular, into a very large Place, which resembled to us the form of a Horse-shoe; for we stuck lighted Candles all the way we went, to discover what we could find remarkable. At length we came to a River or great Water, which I found to be 20 Fathoms broad, and 8 Fathoms deep. The *Mine-Man* would have persuaded me, that this River ebbed and flowed, for that some 10 Fathoms above the Place we now were in, we found the Water had sometimes been: But I proved the contrary,

rary, by staying there from 3 Hours *Flood* to 2 Hours *Ebb*, in which time we found no alteration of this River. Besides, its Waters are Fresh, Sweet and Cool, and the Surface of this Water as it is now at 8 Fathom deep, lies lower than the bottom of any part of the *Severn Sea* near us, so that it can have no community with it. As we were walking by this River 32 Fathoms under the Ground, we discovered a great Hollowness in a Rock some 3 Foot above us; so that I got a Ladder down to us, and the *Mine-man* went up the Ladder to that place, and walk'd into it about 70 Paces, till he just lost a sight of me, and from thence chearfully call'd unto me, and told me he had found what he look'd for, a *Rich Mine*. But his Joy was presently turn'd into Amazement, and he return'd affrighted by the sight of an *Evil Spirit*, which we cannot persuade him but he saw, and for that Reason will go thither no more.

Here are abundance of strange Places; the Flooring being a kind of white Stone enamel'd with *Lead Ore*, and the pendant Rocks were glazed with *Salt Peter*, which distilled upon them from above, and time had petrify'd.

Four Days together after his return, Capt. *Sturmy* was troubled with an unusual and violent Head-ach, which he imputed to his being in that Vault; and falling from his Head-ach into a Fever, he soon after died. By Sir Rob Southwell. ib.

2. 'Tis down the *Tunnel*, C C, from the *Superficies* of the *Earth* A A, to the opening of the *Cavity* below, 39 Yards. Then the *Hole* E E, spreading into an irregular Oblong Figure, is in the greatest length 75 Yards, and in the greatest breadth 41 Yards. From the highest part of the Roof to the Water was then 19 Yards. The Water H H, was now in a Pool at the North End, being the deepest part; it was in length 27 Yards, in breadth 12, and only five Yards and an half deep. Two Rocks G G and L L, appeared above the Water all covered with *Mud*: But the Water was sweet and good. There was a large Circle of *Mud*, K K K, round the Pool, and far up towards the South End, which shew'd that the Water has at other times been 6 Yards higher than at this present. By Captain Collins. ib. p. 4. Fig. 1. 72, 73.

Sept. 18, and 19, 1682. The *Tunnel* or Passage down, was somewhat Oblique, very Ragged and Rocky; in some places it was two Yards wide, and in some three or four; but nothing observable therein, save here and there some of that *Sparr* which usually attends the *Mines* of *Lead Ore*. In the Way 30 Yards down, there runs in Southward a Passage D D, of 29 Yards in length, parallel to the *Superficies* above; it was two or three Yards high, and commonly as broad and alike rocky as the *Tunnel*, with some appearances of *Sparr*, but nothing else in it except a few *Batts*.

The *Cavity* below was in like manner Rocky and very Irregular; the Candles and Torches burnt clear, so as to discover the whole extent thereof; nor was the Air any thing offensive.

The bottom of this *Hole* I, where the *Land Waters* do gather, is 59 Yards, down from the *Superficies* of the *Earth*; and by good *Calculation* the same bottom is Twenty Yards above the highest Rising of the *Severn*, and lies into the Land about three Miles distant from it, and about as far from *Bristol*.

Air in
Mines, by
Mr. J. Gill,
n. 26. p. 481.

V. One *John Gill* affirms, from 20 Years Experience of his own, that if in digging deep under Ground, the Workmen meet with Water, they never want *Air* or *Wind*; but if they miss Water (as sometimes it happens, even at 12 or 16 Fathoms deep) they are destitute of convenient Air, either to breathe in, or to make their Candles burn; and that when they drive up an *Adit*, for drawing away a great Quantity of a Winter's standing Water from a deep Mine, as soon as it is brought up so near, that any of the standing Water begins to run away, the Men must secure themselves as well as they can, from Danger of being dashed in pieces against the sides of the *Adit*: For the included Air or Wind, in the standing Water, breaks forth with such a terrible Noise, as that of a piece of *Ordnance*, and with that violence, as to carry all before it, loosening the very Rocks, though at some Distance, in the Work or *Adit*.

To Work in
Mines with-
out Air-
shafts; By
Sir Rob.
Moray, n. 5.
p. 97.

VI. At the Mouth or Entry of the *Adit* (to the *Coal-Mines* of *Liege*) there is a Structure raised of Brick like a Chimney, some 28 or 30 Foot high in all; at the bottom, two opposite sides are, or may be, some $5\frac{1}{2}$ foot broad, and the other two 5 Foot; the Wall $1\frac{1}{2}$ Brick thick. At the lower part of it is a Hole, some 9 or 10 Inches square, for taking out of the *Ashes*, which when it is done, this *Ash Hole* is immediately stopt so close, as Air cannot possibly get in at any part of it. Then some 3 Foot above ground, or more, there is on that side that is next to the *Adit*, or Pit, a square Hole, of 8 or 9 Inches every way, by which the Air enters to make the Fire burn: into this Hole there is fixt a square *Tube* or *Pipe* of Wood, whereof the Joints and Chinks are so stopp'd with Parchment pasted or glewed upon them, that the Air can no where get into the *Pipe* but at the End; and this *Pipe* is still lengthned as the *Adit* or Pit advanceth, by fitting new *Pipes* so, as one end is always thrust into the other, and the Joints or Chinks still carefully cemented, and stopt as before. So the *Pipe* or *Tube* being still carried on, as near as is necessary to the Wall or Place where fresh Air is requisite, while the Air is drawn by the Fire, from thence through the *Tube*, fresh Air must needs come in from without, to supply the place of the other; which by its Motion doth carry away with it all the ill Vapours that breathe out of the Ground: By which means the whole *Adit* will be always fill'd with fresh Air, so that Men will there breathe, as surely as abroad, and not only Candles burn, but Fire, when upon occasion there is use for it for breaking of the Rock.

There must be two of the Iron Grates, that when any Accident befalls the one, the other may be ready to be in its place; the *Coal* being first well kindled in it: But when the Fire is near spent, the Grate being haled up to the Door, is to be supplied with fresh Fewel.

The higher the Shaft of the Chimney is, the Fire draws the Air the better. And this Invention may be made use of in the Pits or Shafts that are perpendicular, or any ways inclining towards it, when there is want of fresh Air at the bottom thereof, or any Molestation by Unwholesome Fumes or Vapours.

The

The whole Contrivance of the Fabrick, may easily be understood by the Fig. 74. annexed Figure.

A The Hole for taking out the *Asbes*, *B* the square Hole into which the *Tube*, or *Pipe*, for conveying the *Air* is to be fitted; *C* the Border or Ledge of *Brick* or *Iron*, upon which the *Iron Grate* or *Cradle* that holds the burning *Coals*, is to rest; the one being exactly fitted for the other: *D* the Hole where the *Cradle* is set; *E* the wooden *Tube*, thro' which the *Air* is convey'd towards the *Cradle*; *F* the *Door*, by which the *Grate* or *Cradle* is let in, which is to be set 8 or 10 Foot higher than the Hole *D*; and the *Shutter* made of *Iron*, or *Wood* that will not shrink, that it may shut very close: *G* the *Grate* or *Cradle*, which is narrower below than above, that the *Asbes* may the more easily fall, and the *Air* excite the *Fire*, the Bottom and Sides being barred; *H* the *Border* or *Ledge* of the *Cradle*, that rests upon Ledge *C*; *I* four *Chains* of *Iron* fastened to the four Corners of the *Cradle*, for taking it up and letting it down; *K* the *Chain* or *Iron* to which the other *Chains* are fasten'd; *L* the *Pully* of *Iron* or *Brass* through which the *Chain* passeth; *M* a *Hook* on which the *Chain* is fasten'd by a *Ring*, the *Hook* being fixed at the Side of the *Door*; *N* a *Bar* of *Iron* in the Walls, to which the *Pully* is fasten'd.

VII. 1. In a *Coal-pit* belonging to the Lord *Sinclair* in *Scotland*, where the *Coal* is some 18 or 20 Foot thick, and anciently wasted to a great Depth; the *Colliers*, some Weeks ago, having wrought as deep as they could, and being to remove into new Rooms, as they call 'em, did, by taking off, as they retired, part of the *Coal* that was left as *Pillars*, to support the *Roof* and *Earth* over it, so much weaken them, that within a short Space after they were gone out of the *Pit*, the *Pillars* falling, the *Earth* above them filled up the whole Space, where the *Colliers* had lately wrought, with its Ruins. The *Colliers* being hereby out of work, some of them adventur'd to work upon old Remains of Walls so near the old Wastes, that striking thro' the slender Partition of the *Coal-Wall*, that separated between them and the Place where they used to work, they quickly perceived their Error; and fearing to be stifled by the bad Air, that they knew possessed these old Wastes, in regard not only of the *Damps* which such Wastes do usually afford, but because there had been, for many Years, a *Fire* in those Wastes that filled them with stifling Fumes and Vapours, retired immediately, and saved themselves from the *Eruptions* of the *Damp*. But next day some 7 or 8 of them came no sooner so far down the Stairs, that led them to the Place where they had been the Day before, as they intended; but upon their stepping into the Place where the Air was infected, they fell down dead, as if they had been shot: And there being amongst them one, whose Wife being informed he was stifled in that place, she went down so far without inconvenience, that seeing her Husband near her, she ventur'd to go to him; but being choaked by the *Damp*, as soon as she came near him, she fell down dead by him.

2. *Damps* happen in most of the *Hungarian Mines*, not only in the *Cuniculi*, or direct Passages, where they walk on Horizontally (by these *Mine-Men* called *Stollen*);

Damps in Mines, by Sir R. Moray,
m. 3. p. 4.

By Dr. Edm. Brown, n.
48. p. 965.

Stollen;) but also in the *Putei*, or perpendicular Cuts or Descents, termed *Schachts* by the same. They are met with, not only in places where the Earth is full of *Clay*, or the like Substances, but also where it is rocky: and one Place they shewed me, in the Copper-Mine at *Hern Groundt*, where there had been a very pernicious Damp, and yet the Rock so hard, that it could not be broken by their Instruments: but the Descent was all made by the means of Gun-powder, ramm'd into long round Holes in the Rock, and so blown up. Another Place they shewed me, where there is sometimes a Damp, and sometimes clear Weather. When there is much Water in the *Mine*, so as to stop up the lower Part of this Passage, then this Damp becomes discoverable, and commonly strong. I procured one to enter it, till his Lamp went out 4 or 5 times, in the same manner as at *Grotto del Cane* in *Italy*.

Some of these Damps suffocate in a short Space of Time; others only render the Workmen faint, with no further Hurt, except they continue long in the Place. The *Miners*, who think themselves no Workmen, if they be not able to cure a Damp, or to cure the bad Weather, or make the Weather, as they term it, perform it by Perflation, by letting the Air in and out; and causing, as 'twere, a Circulation of it: in the Mine at *Hern Groundt*, they did cure a bad Damp by a great Pair of Bellows, which were blown continually for many Days. The ordinary Remedy is by long Tubes, thro' which, the Air continually passing, they are able to dig straight on for a long way, without Impediment in breathing: For some *Cuniculi* are 500 Fathom long, which will not seem strange to any one that shall see the Map of the Copper-Mine at *Hern Groundt*, or the Gold-Mine at *Schemnitz*: And in the Silver Trinity-Mine by *Schemnitz*, I passed quite under a Hill, and came out on the other side. At *Windschach-Mine* by *Schemnitz*, they shewed me the Place where 5 Men and a Gentleman of Quality were lost; for which reason, they have now placed a Tube there. The like they place over all *Docks*, and over all *Ways*, where they dig right on for a great Space, and have no Passage thro'. At *Schemnitz*, they told me, that 28 Men had been killed at one time in 4 *Cuniculi*, 7 in each; and in the sinking of *Leopold's* Pit, which is 150 Fathoms deep, they were much troubled with Damps, which they remedied in this manner:

They fixed a Tube to the side of the *Schacht*, or Pit, from the Top to the Bottom; and that not proving sufficient, they forced down a broad flat Board, which covered, or stopped the Pit, or couched very near the Sides of it, on all sides but where the Tube was, and so forced out all the Air in the Pit through the Tube; which Work they were forced often to repeat. And now they have divers other Passages into it, the Air is good and sufficient, and I was drawn up thro' it without the least Trouble in breathing.

But, besides this Mischief from poisonous Exhalations, Stagnation of the Air or Water, impregnated with mineral Spirits, they sometimes perish by other ways: For there being in these Mines an incredible Mass of Wood to support the Pits, and the Horizontal Passages, (the *Putei* and *Cuniculi*) in all places but where it is rocky, Men are sometimes destroy'd by the Wood set on fire. And in the Gold-Mine at *Schemnitz*, the Wood was set

set once on fire by the Carelessness of a Boy, and 50 Miners smothered thereby; who were all taken out but one, that was afterwards found to be dissolved by the *Vitriol Water*, nothing escaping either of *Flesh* or *Bones*, but only some of his *Clothes*.

3. There are 4 sorts of *Damps*; the first is the ordinary sort: the external Signs of its Approach, are the *Candles* burning orbicular, and the *Flames* lessening by degrees, until it quite extinguish; the internal, Shortness of *Breath*. I never heard of any great Inconvenience which any one suffer'd by it, who escaped swooning: Those that swoon away, and escape an absolute Suffocation, are, at their first Recovery, tormented with violent Convulsions; the Pain whereof, when they begin to recover their Senses, causeth them to roar exceedingly. The ordinary Remedy is to dig a Hole in the Earth, and lay them on their Bellies, with their Mouths in it; if that fail, they run them full of good Ale; but if that fail, they conclude them desperate. I have known some, who have been recovered after this manner, (when some of their Companions have, at the same time, died) that told me, they found themselves very well, within a little time after they had recovered their Senses, and never after found themselves the worse for it.

They call the 2d sort the *Pease-bloom Damp*; because, as they say, it smells like *Pease-bloom*: They tell me, it always comes in the Summer-time; and those Grooves are not free, which are never troubled with any other sort of *Damps*. I never heard that it was mortal; the Scent perhaps freeing them from the Danger of a Surprise: but, by reason of it, many good Grooves lie idle at the best and most profitable Time of the Year, when the *Subterraneous Waters* are at the lowest. They fancy it proceeds from the Multitude of red Trefoyle Flowers, by them called Honey-Suckles, with which the Limestone Meadows in the *Peake* do much abound.

The 3d is the strangest and most pestilential of any, if all be true which is said concerning it; those who pretend to have seen it (for it is visible) describe it thus: In the highest Part of the Roof of those Passages which branch out from the main Groove, they often see a round thing hanging, about the bigness of a Foot-Ball, covered with a Skin of the Thickness and Colour of a Cobweb; this, they say, if by any Accident, as the Splinter of a Stone, or the like, it be broken, immediately disperseth itself, and suffocates all the Company. Therefore to prevent Casualties, as soon as they have espied it, they say, they have a way, by the help of a Stick and a long Rope, of breaking it at a distance; which done, they purify the Place well with Fire, before they dare enter it again. I dare not avouch the Truth of this Story in all its Circumstances, because the Proof of it seems impossible, since they say it kills all that are likely to bear Witness to all the Particulars; neither dare I deny, but such a thing may have been seen hanging on the Roof, since I have heard many affirm it. Our *under-ground Philosophers* say, The Steam which arises from their Bodies, and the Candles, ascends into the highest Part of the Vault, and there condenseth; and in time has a Film grown round about it, and at length corrupting, becomes pestilential.

By Mr.
Jeffop. n.
117. p. 391.

The

The 4th, which they also call a *Damp*, (altho' how proper, I will not argue) is that Vapour, which being touch'd by the Candle, presently takes Fire; and giving a Crack like a *Gun*, produceth the like Effects, or rather those of *Lightning*. A Fellow they commonly call *Dobby Leech*, is, at this day, a sad Example of the Force of one of those Blasts in *Hastleberg-Hills*, having his Arms and Legs broken, and his Body strangely distorted.

Captain *Wain* told me, he saw one of them in a *Bloomery* near *Peniston*.

n. 119. 450.

This *fulminating Damp* has lately done some Hurt, in a Coal-pit at *Wingsworth*, two Miles from *Chesterfield*.

The *Shaft* of the *Coal-pit* is about 15 Yards deep, the Soil a stiff Mire, shaly about the Middle of the *Shaft*, dry at the *Bottom*, as they say, (tho' I observed some Moisture about the Middle) and without any *Quarry* of *Stone*; the *Stones* in the Field about it are *Grit-stone*. It lies almost at the *Bottom* of a rising Ground, being encompassed with *Hills* on all sides, except towards the East, or rather South-East.

There are 3 Pits which lie almost in a direct Line, the middlemost of which, is that we speak of. There is also a fourth, which stands a little higher than the rest.

From the *Bottom* run 4 *Binks*, as they call them, 4 Yards wide, and 40 Yards long; except that in which they meet the fiery *Damp*, which wants 4 or 5 Yards of its due Length.

The *Bink* in which the *Damp* is, is the farthest from the Air, which is communicated from the other *Pits*.

The Soil of this *Bink* (as they tell me) is a stiff Clay; neither can they find in it the Sign of any *Mineral*, except *Coal* and *Shale*. The *Coal*, they say, is absolutely free from the *Pyrites*, with which most of our *Coals* are infected.

The *Bink* in which the *Damp* is, was wrought forward 20 Yards on *Whitson Monday* 1675, when *Geo. Mitchell* (one of my Informers) going in to fetch some of his Tools, with a Candle in his Hand; and coming within 4 or 5 Yards of the further End, found himself, on a sudden, he knew not how, environed with Flames. His Face, his Hands, his Hair, and a great Part of his Clothes, were very much burnt. He heard very little Noise, altho' one *Edward Mitchell*, who was working at the same time in another *Bink*, told me, that both he, and all those that stood above Ground, heard a very great one, like a Clap of Thunder; and that the Earth shook, so that he was afraid the Roof would have fallen in and buried him.

This being the first Accident of this nature, those without ran in a great Amazement, with their Candles in their Hands, to see what the Matter was, which were twice extinguish'd, but held in upon the 3d Lighting: they saw nothing, but met with an intolerable Stench of *Brimstone*, and an Heat as scalding as an Oven half heated, (for that was their Expression) which forced them very speedily to quit the Place.

Notwithstanding this, they wrought forwards for about 3 Weeks, and carried it on till betwixt 30 and 40 Yards, until one *Henry Turnelly* met with the same Accident, which had formerly befallen *Mitchell*, and *Mitchell* had also the Misfortune to have his Share in this; for being by chance under ground

at

at the Mouth of the *Bink*, he was shot forth for about 2 or 3 Yards, and had his Head broken, and his Body bruised against the further side.

About a Week after, *Edward Mitchell*, another of my Informers, adventuring in again, met with the same Misfortune, and was worse scorched than any of the rest.

The things I chiefly took notice of, were these :

1. That those who were in the *Bink*, whilst it was fired, never heard any more Noise, than that which is usually made by a Flash of Gun-powder in the open Air, although those in the other *Binks* and out, heard a very great one.

2. It shot off the *Turn* at the Mouth of the Pit, and small Coals, with other Rubbish from the bottom, into the Air, to a considerable Height.

3. They could perceive no Smell before the Fire; but afterwards a very strong Smell of Brimstone.

4. They used to go with their *Candles* low, as near as could be to the Bottom, because they perceived the Vapour to lie towards the Roof, which if they held their *Candles* higher than ordinary, they could see descend like a black Mist, and catch hold of the Flame, lengthen it to two or three handfuls, which would nevertheless burn after the usual manner, without any further Mischief, if they suddenly held down their Hands close to the Ground.

5. The *Flame* would continue in the *Vault* for 2 or 3 Minutes after the Crack; the last time, which was the most violent, they thought it continued about half a Quarter of an Hour.

6. The Colour of the *Flame* was blue, and very bright, something inclining towards green.

7. Altho' they told me, they were sensible of no Smell, before the kindling of the Vapour, yet the *Colliers Clothes* that worked in the adjoining Pits, smelt very strong of Brimstone; which makes me suspect all the Pits to be infected, altho' the Air secures them from Mischief. Their Insensibility I ascribe to the Custom.

To the Queries suggested by Mr. *Boyle*, I answer as followeth :

1. That *Damps* are generally observ'd to come about the latter end of May, and to continue during the Heat of Summer; and in those Places which have *Damps* all the Year long, they observe them to be most violent at that Season: and I could meet with no other certain Rule for any periodical Returns, except this annual; altho' it be certain, they do often return in the same Summer.

2. I never heard of any *Damps* that kindled of themselves; altho' I have been told, that in some Places they have been kindled by the Motion of the Sled in which they draw their Coals.

3. *Damps* generally are held to be heavier than the Air, but this was manifestly lighter; for it lay towards the top of the *Bink*.

4. Upon the breaking of the *fulminating Damp*, there proceeded a dark Smoke, of the Smell and Colour of that which proceeds from Gun-powder fired.

5. Many *Damps* are seen, but many also are not seen ; which, whether they be visible or no, is hard to tell : but I suppose all would be visible, had we a convenient Light to view them by ; because be they either thicker or thinner than the Air, that Density or Thinness, will occasion a Refraction ; and that must needs render them visible.

6. Some *Damps* will quite extinguish all those Fires that are let down into them, be they ever so many successively, or ever so great ; and Fire is observed to be so far from curing, that it often creates *Damps* in Places not otherwise subject to them. Indeed they are a present Remedy, if you can so order them, as by their Help to make a Circulation of the Air, through the infected Place ; otherwise they do Hurt : And those *Grooves* wherein they are forced to break their Rocks, by the Help of great Fires, are seldom free from *Damps*.

7. Men usually work in Places infested either by the fulminating, or other *Damps*, after they suppose the *Vapour* spent.

8. *Damps* are common, both in wet and dry Ground ; but I cannot tell in which most.

9. *Damps* are observed to be most pestilential, and to kill the suddenest, that are in *Grooves* not stirred for many Years, especially if such *Grooves* have formerly had great Fires in them.

10. The general Opinion of our Workmen is, That there are some *Damps* which kill, by reason of the noisome *Steam* ; and others meerly by want of *Air* ; which latter Opinion I have heard disallow'd by the more experienced Sort : For they say, That there is no *Groove* that wants *Air*, be it ever so deep ; but the *Air* stagnating in very deep *Grooves* or *Pits*, the grosser Parts must needs at length separate themselves by their own Weight, and subsiding to the Bottom, there corrupt, and consequently get malignant Qualities, especially in the Summer-time, when the Sun promotes the Fermentation. Besides this, the standing *Air* being in a short time filled with the *Vapours* arising from Mens Bodies, and the *Steams* of *Candles*, and passing so often thro' the Lungs of the *Workmen*, is quickly render'd unfit for that Use (whatsoever it is) to which *Respiration* is accommodated : And this they take to be the most frequent Cause of ordinary *Damps*.

Damps will often follow the *Water* ; and particularly this sort of fiery *Damp*, if I am rightly inform'd.

By Mr. Rog.
Mostyn, n.
136. p. 895.

4. The Coal-work at Mostyn in Flintshire, lies in a large Parcel of Wood-land, which hath a great Fall directly North to the Sea-side ; but the Dipping or Fall of the Coal partly crossing the Fall of the Ground, is within a Point of due East, and lies 40, 50, and sometimes 60 Yards under the Level of the Sea. This Work is upon a Coal of five Yards in Thickness, and hath been begun upon about six or eight and thirty Years ago. When it was first found, it was extreme full of *Water*, so that it could not be wrought down to the Bottom of the Coal ; but a *Witchet* or *Cave* was driven out in the middle of it upon a Level, for gaining room to work, and drawing down the Spring of *Water*, that lies in the Coal, to the Eye of the Pit ; in driving of which *Witchet*, after they had gone a considerable Way under ground, and were scant

scanted of *Wind*, the *Fire-damps* did begin by little and little to breed, and to appear in *Crevises* and *Slits* of the *Coal*, where *Water* had lain before the opening of the *Coal*, with a small *bluish Flame*, working and moving continually, but not out of its first *Seat*, unless the *Workmen* came and held their *Candles* to it; and then being weak, the *Blaze* of the *Candle* would drive it with a sudden *Fizz*, away to another *Crevise*, where it would soon after appear blazing and moving as formerly. This was the first *Knowledge* of it in this *Work*, which the *Workmen* made but a sport of, and so partly neglected it, till it had gotten some strength; and then upon a *Morning*, the first *Collier* that went down, going forwards in the *Witchet* with his *Candle* in his *Hand*, the *Damp* presently darted out so violently at his *Candle*, that it struck the *Man* clear down, singed all his *Hair* and *Clothes*, and disabled him from working a while after. Some other small *Warnings* it gave them, insomuch that they resolved to employ a *Man* on purpose, that was more resolute than the rest, to go down a while before them every *Morning* to chase it from place to place, and so to weaken it. His usual manner was to put on the worst *Rags* he had, and to wet them all in *Water*, and as soon as he came within the danger of it, then he fell down groveling on his *Belly*, and went so forward, holding in one hand a long *Wand* or *Pole*, at the end whereof he tied *Candles* burning, and reached them by degrees toward it; then the *Damp* would fly at them, and if it missed of putting them out, it would quench it self with a *Blast*, and leave an ill-scented *Smoak* behind it. Thus they dealt with it till they had wrought the *Coal* down to the bottom, and the *Water* following, and not remaining as before in the *Body* of it, among *sulphurous* and *brassy Metal* that is in some *Veins* of the *Coal*, the *Fire-damp* was not seen nor heard of till the latter End of the Year 1675, which happened as followeth.

After long working of this *Coal*, it was found upon the rising *Grounds*, that there lay another *Roach* of *Coal*, at the *Depth* of 14 *Yards* under it, which proved to be $3\frac{1}{2}$ *Yards* thick, and something more *sulphurous*. This encouraged us to sink in one of the *Pits* we had formerly used on the 5 *Yards Coal*; and we sunk down 20 *Yards* before we came to the said *Roach*, in regard it was at the *Sea-side*, and upon the lowest of the *Dipp*, where the *Rocks* successively thicken as they fall. As we sunk the lower part of it, we had many *Appearances* of the *Fire-damp* in watry *Crevises* of the *Rocks* we sunk thro, *Flashing* and *Darting* from side to side of the *Pit*, and shewing *Rain-bow-colour* like on the *Surface* of the *Water* in the bottom; but upon drawing up of the *Water* with *Buckets*, which stirr'd the *Air* in the *Pit*, it would leave burning, till the *Colliers* at work, with their *Breath* and *Sweat*, and the *Smoke* of their *Candles*, thickned the *Air* in the *Pit*, and then it would appear again; they lighted their *Candles* in it sometimes when they went out, and so in this *Pit* it did no further Harm.

But being desirous to get the *Work* in some forwardness before *Summer*, (when the *Heat* of the *Weather* at some times, and the *Clofeness* of the *Air* in foggy *Weather* at other; occasions the *smothering Damp*) it was resolved for *Expedition-sake*, and saving of some *Charges*, to sink a *Pit* within the *Hollows*

or *Deads* upon the *upper Work*, at 16 or 17 Yards distance from the *first Pit*. This we proceeded in, till we came 6 or 7 Yards deep; then the *Fire-damp* began to appear as formerly, accompanying the *Workmen* still as they sunk; and they using the same Means as afore, sometimes blowing it out with a *Blast* of their *Mouth*, at other times with their *Candles*, or letting it blaze without *Interruption*. As we sunk down, and the *Damp* got still more and more Strength, we found that our want of *Air* perpendicularly from the *Day*, was the great *Cause* and *Nourisher* of this *Damp*; for the *Air* that followed down into this *Pit*, came down at the first-sunk *Pit*, at the foremention'd Distance, after it had been dispersed over all the old *Hollows* and *Deads* of the former *Work*, that were filled up with noisome *Vapours*, thick smothering Fogs, and in some Places with the smothering *Damp* itself. Nevertheless, we held on sinking, till we came down to 15 Yards, plying the *Work* Night and Day, (except *Sundays* and *Holidays*) upon which Intermiſſion, the *Pit* being left alone for 48 Hours and more, and the *Damp* gaining great Strength in the interim, by that time the *Workmen* went down, they could see it flashing and shooting from side to side, like *Sword-Blades* cross one another, that none durst adventure to go down into the *Pit*. Upon this they took a Pole, and bound *Candles* several times to the end of it; which they no sooner set over the Eye of the *Pit*, but the *Damp* would fly up with a long sharp Flame, and put out the *Candles*, leaving a foul Smoke each time behind it. Finding that these things would not allay it, they adventur'd to bind some *Candles* at a Hook, hanging at a Rope's end, that was used up and down in the *Pit*: when they had lower'd down these a little way into the *Shaft* of the *Pit*, up comes the *Damp* in a full body, blows out the *Candles*, disperſeth itself about the Eye of the *Pit*, and burneth a great part of the Mens Hair, Beards, and Clothes, and strikes down one of them, in the mean time making a noise like the lowing or roaring of a Bull, but louder; and in the end leaving a Smoke and Smell behind it, worse than that of a Carrion. Upon this Discouragement, these Men came up, and made no further trial; after this, the Water that came from it, being drawn up at the other *Pit*, was found to be blood-warm, if not warmer.

In this Juncture, there was a Cessation of the *Work* for 3 Days; and then the *Steward* thinking to fetch a Compass about from the Eye of the *Pit*, that came from the *Day*, and to bring Wind by a secure Way along with him, that if it burst again, it might be done without Danger of Mens Lives, went down, and took 2 Men along with him, which served his turn for this Purpose. He was no sooner down, but the rest of the *Workmen* that had wrought there, disdaining to be left behind in such a time of Danger, halted down after them; and one of them, more indiscreet than the rest, went headlong with his Candle over the Eye of the *Damp-pit*, at which the *Damp* immediately catch'd, and flew to and fro over all the *Hollows* of the *Work*, with a great Wind, and a continual Fire; and as it went, keeping a mighty great roing Noise on all sides.

The Men, at first appearance of it, had most of them fallen upon their Faces, and hid themselves as well as they could, in the loose *Sleck*, or *Small-coal*, and under

under the Shelter of Posts ; yet nevertheless, the Damp returning out of the Hollows, and drawing towards the Eye of the Pit, it came up with incredible Force: the Wind and Fire tore most of their Clothes off their Backs, and singed what was left, burning their Hair, Faces and Hands, the Blast falling so sharp upon their Skin, as if they had been whipt with Cords ; some that had least Shelter, were carried 15 or 16 Yards from their first Station, and beaten against the Roof of the Coal and Sides of the Posts, and lay afterwards a good while senseless, so that it was long before they could hear or find one another. As it drew up to the Day-Pit, it caught one of the Men along with it, that was next the Eye, and up it comes with such a terrible Crack, not unlike, but more shrill than a Cannon, that it was heard 15 Miles off, with the Wind ; and such a Pillar of Smoak, as darken'd all the Sky overhead for a good while. The Brow of the Hill above the Pit, was 18 Yards high, and on it grew Trees 14 or 15 Yards long ; yet the Man's Body, and other things from the Pit, were seen above the Tops of the highest Trees, at least 100 Yards. On this Pit stood a Horse-Engine of substantial Timber, and strong Iron Work ; on which lay a Trunk, or Barrel, for winding the Rope up and down, of above 1000 Pounds Weight ; it was then in motion, one Bucket going down, and the other coming up full of Water : This Trunk was fastened to that Frame with Locks, and Bolts of Iron ; yet it was thrown up, and carried a good way from the Pit ; and Pieces of it, tho bound with Iron Hoops, and strong Nails, blown into the Woods about : so likewise were the two Buckets ; and the Ends of the Rope, after the Buckets were blown from them, stood a while upright in the Air like Pikes, and then came leisurely drilling down. The whole Frame of the Engine was stirr'd and mov'd out of its Place ; and those Men's Clothes, Caps, and Hats, that escaped, were afterwards found shatter'd to pieces, and thrown amongst the Woods a great way from the Pit. This happened the 3d of Feb. 1675, being a Season when other Damps are scarce felt or heard of.

5. About 2 Miles on the South-East of *Stony Easton*, at a Place nearly bordering to *Mendip-Hills*, begins a Running of Coal consisting of several Veins, which extends itself towards the East about 4 Miles. There is much Working in this Running, and Fire-Damps continually there happen ; so that many Men of late Years have been there kill'd, many others maimed, and a Multitude burnt ; some have been blown up at the Work's Mouth, the *Turn-Beam* (which hangs over the *Shaft*) has been thrown off its Frame by the Force of it ; and those other Effects, whereof you had an Account from other Places, are generally found. The Middle, and more easterly Parts of this Running are so very subject to those fiery Damps, that scarce a Pit fails of them : notwithstanding which, our Colliers still pursue their Work ; but, to prevent Mischiefs, they keep their Air very quick, and use no Candles in their Works but of a single Wick, and those of 60 or 70 to the Pound, which nevertheless give as great a Light there, as others of 10 or 12 to the Pound in other Places ; and they always place them behind them, and never present them to the Breast of the Work.

By Mr. J.
Beaumont,
Phil. Col. n. 1.
p. 6.

When

When any are burnt, the usual Method they observe in their Cure is thus : They presently betake themselves to a good Fire, and sending for some Cow's hot Milk, they first bathe the burnt Places with that ; when they have done this a while, they make use of an Ointment proper for Burnings, which the Masters of the Works have always in a readiness for such Chances, being furnished therewith at the cheap Rate of 12 *d.* the Pound, by a good old Woman living near the Works.

The Colliers assure me, That these Works are apt to take Fire all the Year, which they will freely do at any time, if a Candle be carry'd within Air ; but most and with most Violence in the Winter, and chiefly in a Black-Frost, when the Air runs best : that the Danger of firing is alike, both in wet and dry Grounds ; and that there are no Fumes coming out of the Mouth of any Shaft, which will be lighted by a Candle or Torch.

I have heard of one Damp here, which took Fire of itself, and kindled the Vein of Coal, which burnt a considerable time before it went out.

Our Damps lie as well towards the Bottom or Seal of the Work, as towards the Roof ; it being nothing but an invisible sulphurous Breath, expanded thro' the whole Work.

I cannot perceive, at the Mouth of any Shaft, or understand by any Workman, that any unusual Wind or Current of Vapours comes from beneath. In wet Works, there are many times Bubbles on the Surface of Water there standing, which will presently take fire, if a Candle be held to them : But I cannot find that those Bubbles are caused by any subterraneous Breath, but rise from the falling of Coal into the Water, or from dropping of Water from the Roof, as we see they do in Ponds, from Drops of Rain in the Summer.

I may here further acquaint you, as a Novelty, That this last Summer 1679, two Fire-Damps happen'd in our Lead-Mines on *Mendipp-Hills* ; but they were of so small Force, that the Workmen received no Prejudice by 'em.

A Well and Earth in Lancashire taking Fire at a Candle, by Mr. Tho. Shirley, n. 26. p. 482.

VIII. About the latter End of *Feb.* 1659, returning from a Journey to my House in *Wigan*, I was entertained with the Relation of an odd Spring, situated in one Mr. *Hawkley's* Ground (if I mistake not) about a Mile from the Town, in that Road which leads to *Warrington* and *Chester* : the People of this Town did confidently affirm, That the Water of this Spring did burn like Oil.

When we came to the said Spring (being 5 or 6 in company together) and applied a lighted Candle to the Surface of the Water ; 'tis true, there was suddenly a large Flame produced, which burnt vigorously : But observing that this Spring had its Eruption at the Foot of a Tree, growing on the Top of a neighbouring Bank, the Water of which Spring filled a Ditch that was there, and covered the burning Place ; I applied the lighted Candle to divers Parts of the Water contained in the said Ditch, and found as I expected, that upon the Touch of the Candle and the Water, the Flame was extinct.

Again, having taken up a Dish full of Water at the flaming Place, and held the lighted Candle to it, it went out. Yet I observed that the Water, at the Burning-

Burning-Place, did boil, and heave, like Water in a Pot upon the Fire, tho' my Hand put into it, perceived it not so much as warm.

This Boiling I conceived to proceed from the Eruption of some bituminous or sulphureous Fumes ; considering this Place was not above 30 or 40 Yards distant from the Mouth of a Coal-Pit there : and indeed *Wigan, Ashton*, and the whole Country, for many Miles compass, is underlaid with Coal. Then applying my Hand to the Surface of the Burning-place of the Water, I found a strong Breath, as it were a Wind, to bear against my Hand.

When the Water was drained away, I applied the Candle to the Surface of the dry Earth, at the same Point where the Water burned before ; the Fumes took fire, and burned very bright and vigorous. The Cone of the Flame ascended a Foot and a half from the Superficies of the Earth ; and the Basis of it was of the Compass of a Man's Hat about the Brims. I then caused a Bucket full of Water to be pour'd on the Fire, by which it was presently quenched. I did not perceive the Flame to be discoloured like that of sulphureous Bodies, nor to have any manifest Scent with it. The Fumes when they broke out of the Earth, and press'd against my Hand, were not, to my best Remembrance, at all hot.

IX. This subterranean Fire keeps no Analogy with other *Vulcano's* : it increaseth or decreaseth, according to the Subject it feedeth on ; which is, for the most part, a Day-Coal (as they call it ;) for the upper Seam of the Coal is next exposed to the Air, so that you may light a Candle at it in some Places, in other places it is some Fathoms deep, according as the Day-Coal heightens or deepens. *A subterranean Fire in a Coal-Mine Newcastle ; By Dr. Lucan Hodgeson, n. 130. p. 762.*

No Sal-Armoniack, nor any thing like it to be found, except where an actual Fire hath come. There being a Mixture of the Steams of Sal-Armoniack and Sulphur rising together in most places, it is hard to distinguish them ; for, tho the Flowers of Brimstone seem to rise first, yet there is commonly a Crust of Sal-Armoniack under them.

There is a milky Substance, which is found no where, but where the Sal-Armoniack and Sulphur are totally gone ; and the acid Part, or aluminous Spirit of that white Mass, will also take wing by the Increase of the Fire, leaving a *Caput Mort.* dry, stiptick, and as hard as a Stone ; yet I account that a Pound of this Mass, before the Fire press too much upon it, will go near to afford, by Solution, &c. half a Pound of tolerable Chrystalline Allum.

The neighbouring Soil differs little from other Grounds with us, having neither common Salt nor Nitre in it ; for, though there be a Salt-Well with us, yet it is both on the other side of *Tyne*, and a considerable Distance from the Fire.

I have industriously observed the Springs that are near the Fire, and find none of them that give the least Suspicion of Sal-Armoniack. The Water that runs from the adjacent Collieries is Vitrioline, giving as deep a Tincture, with Galls, as *Scarborough-Spaw*. In a word, it differs nothing from the Waters that ordinarily

ordinarily drown our *Collieries*, and cost our Coal-Owners so much to be quit of them. The other Springs, most of which are dry this Year (1676) are of ordinary Use, containing no mineral Salts in them. But I hope you will cease to wonder, that Coal should produce a volatile Salt by the Action of the Fire, seeing I have gathered *Sal-Armoniack* from a burning Brick-Kiln, where nothing but Clay and Coal are burnt together; and I hope none will expect the volatile Salt in the *Sal-Armoniack*, from ordinary Clay. The Reason which first prompted me to seek this Salt there, was, that the Smell of the Kiln did somewhat resemble that of the subterranean Fire. There is also a sort of Mineral we call a Slate, which is partly Coal, partly Allum-stone, partly Marcasite, which being laid up in heaps, and burnt, are used for hardening the Coal-ways; upon these Heaps, whilst burning, I have often gathered both Brimstone and *Sal-Armoniack*.

When I pour'd cold Water upon the powdered Marcasite, it produced a vitrioline Water, but no Heat.

As to the Resemblance betwixt this *Sal-Armoniack*, and that which comes from Mount *Ætna*, where no Coals are supposed to be; whence it seems to follow, that our volatile Salt may proceed from somewhat else than Coal: to this Difficulty I answer, That when I deduced ours from Coal, I did not exclude other bituminous Substances that are Analogous to it, of which I suppose the Country, where Mount *Ætna* is, afforded no inconsiderable Quantity; neither will it follow, that no Coals have been wrought, therefore there are none: and if Tryal hath been made, and no Coals found, yet it will be a doubt still, whether those Tryals have been sufficient. However it be, yet I think it were not impertinent (by the way) to enquire, whether the sagacious *Venetians* may not be beholden to Mount *Ætna*, or some other subterranean Fires, for the great Quantity of *Sal-Armoniack* they sell to our Merchants; for this Fire affordeth no inconsiderable Quantity thereof, especially in dry Weather.

Though it may seem incredible to some, that black Coal should yield a white snowy volatile Salt; yet they that know that all volatile Salts whatever may be freed from their *Fætor* and intense Colour, by transmuting them into a *Sal-Armoniack* by the Mediation of an *Acid*, as Spirit of Salt, Spirit of Vitriol, Allum, &c. and then subliming them till they be white, will cease to doubt of this matter. The Reason of which Change, I presume, is, Because, though these volatile Salts carry over always some of the *Fætid Oil* with them, while in a State of Volatility; yet being thus in a manner fixed, the *Fætid Oil* must necessarily, by force of Fire, rise first, leaving the subsequent compound Salt, or *Sal-Armoniack*, without Smell; though it is still a doubt, whether the volatile Salt is better or worse for this Labour.

We have no Petrescent Springs near us; but there is a Cave some Miles off, at the farthest End of which few have been, from the Roof of which hang large Lumps of petrified Water, like Icicles, some of them reaching down to the Ground like Pillars; these Icicles are good Limestone, as I have tried.

X. I have lately received an Account from my Brother, that on a side of one of the *Appennine Mountains* half way betwixt *Bologna* and *Florence*, near a Place called *Petra Mala*, about 5 Miles from *Fierenzola*, there is a Spot of Ground about 3 or 4 Miles Diameter, which incessantly sends up a Flame rising very high, without Noise, Smoak, or Smell; yet it gives a very great Heat, and it has been observed to be thus in all times, except of great Rains, which put it out for a time; but when that is over, it burns with greater Vigour and Heat than before. The Sand about it, when turned up, sends up a Flame: but within 3 or 4 Yards of it there grows Corn all round about; for it continues always in the same Spot.

This Flame seems to proceed from a Vein of *Bitumen* or *Naphtha*, that Crops (as the Miners call it) only here; which when by Plowing, or some other Accident, the upper Crust has been turned up, was kindled into a Flame by the Heat and Agitation of the Air, as other *Salino-Sulphureous* Bodies are, of which Esquire *Boyle's Phosphorus* is a particular Instance. The like *Spontaneous Ascension* is seen in many *Mineral Substances*, but none that I know of, so quick in its Production, or so lasting, as this is; the whole Wood and Fields having been destroyed by them. The Neighbours there have been so little curious to observe it, that they believed there was a great Hole in the Flame-Place; but he found it to be firm Ground. Neither does any there remember when and upon what Occasion it first began. The *Flaming Well* near *Wigan* seems to proceed from a Cause much like this, in which you may boil an Egg, and upon the approaching of a Lighted Candle, it takes Fire; both seem to proceed from a *Naphtha* or *Subtile Bitumen*, only that in a hotter Country, and being in a dryer Soil, is more Subtile and Inflammable: just as the *Petroleum* which is to be found in *Italy* is a White like *Spirit of Turpentine*, and is more penetrating than the *Petroleum* which is to be found in the Northern Countries; an instance of which we have in a Well two Miles distant from *Edinburgh*, called the *Baulme Well*, of a Black Red Colour and very Thick, but being distilled, does in Colour, Taste and Smell, resemble that of *Italy*.

The *Spontaneous Ascension* of the *Naphtha* seems to be made out by the Smell that our *Bitumen* near *Edinburgh* yields, being most like *Coal Smoak*. There are three such Fires on the same Hills that are extinguish'd in the Summer, but burn in the Winter; the reason of which I judge to be, that the Bowels of the Earth being cooler in the Summer than in Winter, do not send forth that Quantity of those *Subtile Exhalations*, as may be sufficient to maintain a Flame in Summer; but in Winter, the Bowels of the Earth being hotter (which is made evident by the smoaking of Springs in Winter, and not in Summer, and the Experience of Miners) greater Plenty of Steams are sent forth, which in the Air are agitated into a Flame, the brisk Motion of the Parts one against another being promoted by the Subtily and brisk Motion of the *Aerial Particles*, *que mutuas dant operas*.

An Historical
Account of
the Eruptions
of Mount
Ætna; by
Mr. Olden-
burg. n. 48.
p. 967.

Lib. 3.
Æneid.

XI. To pass by what is related by *Berosus*, *Orpheus*, and other less credible Authors, about the Eruptions of this Mountain, both at the time of the Ingress of the *Ionian Colonies* into *Sicily*, and that of the *Argonauts* (which latter was in the 12th Age before the Christian Account;) we shall first take notice of that which happen'd at the time of the Expedition of *Æneas*: who being terrify'd with the Fire of this then burning Mountain, left that Island; whereof *Virgil* gives a notable Description.

After this, we find in *Thucydides*, that in the 76 Olympiad, which is about 476 before Christ, there was another Fire; and about 50 Years after that, another.

Then, in the time of the Roman Consuls, there happen'd 4 Eruptions of *Ætna*, recorded by *Diodorus Siculus*, and *Polybius*.

The next was in the time of *Julius Caesar*, related by the said *Diodorus*, to have been so fierce, that the Sea about *Lipara* (an Island near *Sicily*) by its fervent Heat, burnt the Ships, and killed all the Fishes thereabout.

Another we read of in the Reign of *Caligula*, about 40 Years after Christ, which was so dreadful, that it made that Emperor, then being in *Sicily*, to fly for it.

About the Martyrdom of the *Romish S. Agatha*, it burned again very fiercely; though some say, that by virtue of her Intercession, it was stay'd from reaching *Catanea*.

Again it burnt A. C. 812, in the Reign of *Charles M.*

Then from the Year 1160 to 1169, whole *Sicily* was shaken with many terrible Earthquakes; and the Eruptions of the same Mountain destroy'd a vast Tract of inhabited Land round about it, and reach'd as far as *Catanea*; the Cathedral of which it destroyed, and the religious Men living in it.

Again, in the Year 1284, there happened another terrible Fire, about the time of the Death of *Charles King of Sicily and Arragon*.

A. 1329, until 1333, there was another.

A. 1408, another.

A. 1444, another, which lasted till 1447.

A. 1536, another, which lasted a Year.

A. 1633, another, continuing several Years.

A. 1650, it burnt on the North-East side, and vomited so much Fire, that by the fiery Torrents, caused thereby, great Devastation was made; as *Kircher* relates in his *Mundus Subterraneus*; whose Assistance we have also made use of, in the foregoing Chronology, together with that of *Philoxenus*.

The same Author, having been in *Sicily* himself, observeth, that the People of *Catanea*, digging for *Pumice-Stones*, do find at the Depth of 100 *Palms*, (which is about 68 Feet) Streets, paved with Marble, and many Footsteps of Antiquity; an Argument, that Towns have stood there, in former Ages, which have been overwhelmed by the Matter cast out of this Mountain. They have also found several Bridges of *Pumice-Stones*,

Stones, doubtless made by the Flux of fiery Torrents, the Earth being very much raised since.

XII. There was for the Space of 18 Days before this Fire broke out, a very thick dark Sky in those Parts, with Thunder and Lightning, and frequent Concussions of the Earth; which the People make terrible Reports of, tho' I never saw nor heard of any Buildings cast down thereby, save a small Town, or Village, called *Nicolosi*, about half a Mile distant from the new Mouth, and some such other slight Buildings among those Towns, that were after over-run by the Fire. Besides, it was observ'd, that the old Top or Mouth of *Ætna* did, for 2 or 3 Months before, rage more than usual; the like of which did *Volcan* and *Strombolo*, two burning Islands to the Westward: And the Top of *Ætna*, much about the same time, has sunk down into its old *Vorago* or Hole, in that 'tis agreed by all, that had seen this Mountain before, that it was very much lower'd.

It first broke out on the 11th of *March*, 1669, about two Hours before Night, and that on the South-East-side, or Skirt of the Mountains, about 20 Miles between the *Old-Mouth*, and 10 Miles from *Catanea*. At first it was reported to advance 3 Miles in 24 Hours; but at our being there (*viz.* April 5.) when we were come within a short Mile of *Catanea*, it scarce moved after the rate of a Furlong a Day; and after this Degree of Progress it continued for 15 or 20 Days after, passing under the Walls of *Catanea*, a good way into the Sea: But about the latter end of this Month, and the beginning of *May*, (whether it was, that the Sea could not receive this Matter fast enough, or rather that the Mouth above did cast out a larger Quantity) it bent all its Force against the City; and having wrought itself up even with the Walls thereof, over it passed in divers Places: but its chief Fury fell upon a very pretty Convent, which was that of the *Benedictines*, having large Gardens and other Grounds betwixt them and the Wall; which, when it had filled up, it fell with all its Force on this Convent, where it met with strong Resistance; which made it swell (as usually it did, where it met with any Obstruction) almost as high as the higher Shops in the old *London-Exchange*; this Convent being built much after that Fashion, though considerably bigger. Some Parts of this Wall were driven in, whole and entire, almost a Foot; as appear'd by the rising of the Tiles in the midst of the Floor, and bending of the Iron-Bars that went cross above. And 'tis certain, had this Torrent fallen in some other Part of the Town, it would have made great havock amongst their ordinary Buildings; but here its Fury ceased upon the 4th of *May*, running henceforward in little Channels or Streams, and that chiefly into the Sea. It had overwhelmed in the Up-land Country, some 14 Towns and Villages, whereof some were of good Note, containing 3 or 4 thousand Inhabitants, and stood in a very fruitful and pleasant Country, where the Fire had never made any Devastation before: But now there is not so much as any Sign where such Towns have stood; only the Church and Steeple of one of them, which stood alone upon an high Ground, does still appear.

An Eruption
of M. Ætna
in 1669, by
some English
Merchants.
a. 51. p. 1028.

As to the Matter which thus ran, it was nothing else but divers kinds of *Metals* and *Minerals*, render'd liquid by the Fierceness of the *Fire* in the *Bowels* of the Earth, boiling up, and gushing forth, as the Water doth at the Head of some great River; and having run in a full Body, for a Stone's Cast, or more, the Extremity thereof began to crust and curdle, becoming, when cold, those hard porous Stones, which the People call *Sciarri*, having the nearest resemblance to huge Cakes of Sea-Coal, full of a fierce Fire. These came rolling and tumbling over one another, and where they met with a Bank, would fill up and swell over, by their Weight bearing down any common Building, and burning up what was combustible. The chief Motion of this Matter was forward; but it was also dilating itself, as a Flood of Water would do on even Ground, thrusting out several Arms, or Tongues, as they call them.

About 2 or 3 a-clock in the Night, we mounted an high Tower in *Catanea*, whence we had a full View of the *Mouth*, which was a terrible Sight; viz. To see so great a Mass, or Body of meer Fire. Next Morning we would have gone up to the *Mouth* itself, but durst not come nearer than a Furlong off, for fear of being overwhelmed by a sudden Turn of the Wind, which carried up into the Air, some of that vast Pillar of Ashes, which, to our Apprehension, exceeded twice the Bigness of *Paul's Steeple* in *London*, and went up in a strait Body to a far greater Height than that; the whole Air being thereabout all covered with the lightest of those Ashes, blown off from the top of this Pillar: And from the first breaking forth of the *Fire*, until its Fury ceased (being 54 Days) neither Sun nor Star were seen in all that Part.

From the outside of this Pillar fell off great Quantity of Stones, but none very big; neither could we discern any *Fire* in them, nor come to see where the fiery Stuff broke out, there being a great Bank, or Hill of Ashes betwixt it and us. At the Mouth, whence issued the *Fire*, or Ashes, or both, was a continual Noise, like the beating of great Waves of the Sea against Rocks, or like Thunder afar off; which, sometimes, I have heard here in *Messina*, though situated at the Foot of high Hills, and 60 Miles off. It hath also been heard 100 Miles Northward of this Place, in *Calabria* (as I have been credibly inform'd) whither the Ashes have been also carried: And some of our Seamen have also reported, that their Decks were covered therewith at *Zant*, though it is likely not very thick.

Kid. Cap. I.
§ 39.

About the middle of *May* we made another Journey thither, where we found the Face of things much alter'd; the City of *Catanea* being 3 Quarters of it compassed round with these *Sciarri*, as high as the top of the Walls, and in many Places it had broken over. The first Night of our Arrival, a new Stream or Gutter of *Fire* broke forth among some *Sciarri*, which we were walking upon an Hour or two before, and they were as high as to be even with the top of the Wall. It poured itself down into the City in a small Gutter of about 3 foot broad, and nine foot long, of meer Fire, the Extremities still falling off into those *Sciarri*; but this Stream was extinct by the next Morning, though it had filled up a great void Place with its *Sciarri*. The next Night was a much bigger Channel discovered, pouring itself over another Part of the Wall into the *Castle-Ditch*, which continued (as we were inform'd) some Days

Days after our Departure. Divers of those small Rivulets did run at the same time into the Sea.

It was observed, that those Streams of Fire never grew broader, nor visibly longer, nor moved out of the place they were seen in, which puts us a little more to examine their Working; and we did conclude, that not only then, but in the Fury also of its running, it made itself certain crusted Gutters to run in, to keep itself, as it were, from the Air, which by degrees did cool and fix it; as more plainly appeared above at the Mouth, where, the first Time of our going thither, we found the *Sciarri* generally thus cold and fix'd. And hence also it might proceed, that these live *Sciarri*, meeting with any Bank or high Ground, would puff and swell up, till they had overcome it: so that in many places, especially under the Walls of *Catanea*, were Valleys of those *Sciarri*, and the Fire never broke forth, or discovered itself in those Streams, until it had gained its Height; for those Rivulets ever went declining.

It having spent 2 Days about *Catanea*, we again went up to the Mouth, where now, without any Danger of Fire or *Ashes*, we could take a free View both of the old and new Channel of the Fire, and of that great Mountain of *Ashes* cast up. That which we guess to be the old Bed or Channel, was a three-corner'd Spot of about 2 Acres, with a Crust or *Sciarri* at the Bottom, and upon that a small Crust or Surface of *Brimstone*. It was hedged in on each side with a great Bank, or Hill of *Ashes*; and behind, and at the upper End, rose up that huge Mountain of the same Matter. Between those two Banks the Fire seems to have had its Passage. At the upper End in the Nook, upon a little Hillock or crusted *Sciarri*, was a Hole about 10 Foot wide, whence it is probable the Fire issued, and it might have had several other such Holes since, either crusted over, or covered with *Ashes*. At the Bottom of this Hole the Fire was seen to flow along, and below it was a Channel of Fire, beneath that Surface of *Sciarri*, which being cleft a-top for some Space, we had an easy and leifurable View of the Metal flowing along, whose *Superficies* might be a Yard broad, tho possibly it carried a great Breadth underneath, the Gutter going sloping. What Depth it had, we could not guess; it was impenetrable by Iron Hooks, and other Instruments we had. We were very desirous to have got some of this Matter at the Spring-head, but we could penetrate no more into it, than with one's Finger into the Palm of the Hand. 'Tis likely that some Running may have been more yielding than we found this. From this Channel, but especially from that Hole above it, issued great Store of a strong *sulphurous Smoak*, wherewith some of our Company were, at first, almost stifled, thro Inadvertency. About once in a Quarter of an Hour, there would rise a Pillar of *Smoak*, or *Ashes*, but nothing comparable to the former, which seemed to come from the middle Top of that new-made Mountain.

At this our last being at *Catanea*, we found the People busy in barricading the Ends of some Streets and Passages, where they thought the Fire might break in; and this they did by pulling down the old Houses thereabouts, and laying up the loose Stones in manner of a Wall, which, they said, would resist the Fire, as not being mixt with *Lime*; though it was the great Weight and Force:

Force of that fiery Matter in pressing forward, and not its burning, that overthrew the Buildings, as plainly appeared in the Convent of the *Benedictines*, and in the *Town-walls*, where the great Deluge of Fire did pour itself; it not breaking into the City, but pouring itself over the *Walls*, as hath been said.

Unto this very time, 'tis said to have run a Mile into the Sea, and as much in Front, tho' it was much less when we were there. The Shore goes gently declining; having at the Extremity of the *Sciarri* about 5 Fathoms, and about half as much they are above Water. The Superficies of the Water, for 20 Foot or more of those Rivulets of Fire, was hotter than to endure one's Hand in it, tho' deeper it was more temperate; and those live *Sciarri* still retained their Fire under Water, as we saw, when the Surges of the Sea retreated back in their ordinary Reverberations.

The general Face of these *Sciarri*, is, in some respect, not much unlike, from the Beginning to the End, to the River of *Thames* in a great Frost, at the Top of the Ice above Bridge; I mean, lying after such a rugged Manner in great Flakes: but its Colour is quite different, being most of a dark dusky Blue, and some Stones, or Rocks, of a vast Bigness, close and solid.

But notwithstanding their *Ruggedness*, and Store of Fire, which we could see glowing in the Clefts and Cavities, we made shift to ramble over a good part of them; as 'tis said also, that People would do the same in its greatest Violence of Burning: For as those live *Sciarri*, and those *Rivers* of Fire themselves, were so tough and impenetrable as to bear any Weight; so the Superficies of the *Sciarri* might be touched and handled, the Fire being inward, and not to be discerned but near hand, especially in the Day-time. And 'twas somewhat a strange Sight, to see so great a River come so tamely forward; for, as it approached unto any House, they not only, at good leisure, removed their Goods, but the very Tiles and Beams, and what else was moveable.

I shall add, That the whole Country, from the very *Walls* of *Catanea* to 20 Miles on this side, is full of those old *Sciarri*, which former Eruptions have cast forth, tho' the People remember none so big as this last, or that burst out so low. This Country is, notwithstanding, well cultivated and inhabited: for length of time hath either mollified much of those old *Sciarri*, or new Moulds or Ashes have overgrown them; tho' there still remains much Country, which, it may be, will never be made serviceable.

What is the perpendicular Height of this Mountain, I cannot learn. It cannot, perhaps, be rightly taken, being so subject to alter its Height and Shape: But it is a very goodly Mountain to look upon, as one passes by Sea to the Eastward, standing alone by itself, rising from the very Shore; and, at shortest Passage, is reckon'd twenty Miles up to the Top, tho' from *Catanea* it hath thirty Miles as before.

a. 52. p. 104. r. A good Quantity of *Ashes* being taken up in divers Parts of and about *Ætna*, some at the Top, or the Mouth of the new made Mountain, some a Mile off, some four, some ten Miles; some but half a Mile distant, and others on the Skirts of the said Mountain; the four first were found

found very dry like Dust; but the two latter being very moist, though in *Sicily* (as we are inform'd) they have lain a good while expos'd to the Heat of the Sun: besides that, the two last differ from one another, in that one sort of them consists of hard and small Lumps, the other of very soft dirty Grains; yet both moist, and of a vitriolate Taste.

Some of the *Sciarri* are coarser, taken up at some distance from the Mouth; and of these some black, with a Crust of *Brimstone*, some of a red Hew, others are finer, and said to be got out of the Gutters of Fire at the very Mouth. Both these kinds are light; but then there is a third sort of Stone, very solid and ponderous, which seems to be made up of a Conflux of divers Minerals melted together.

The Fire spread about three Miles in breadth, and seventeen Miles in length.

XIII. 1. When the Easterly Wind had blown about 6 or 7 Weeks, till, as I guess, about the fourth of *June*, 1693, the Mountain in the Island *Sorca* began early in the Morning, about Day-break, to cast out more Fire than ordinary, which continued for 5 or 6 Days; during which it was dark and cloudy Weather: till at last it brought forth, not only a most prodigious Flame, but also such a black and sulphurous Vapour, that the Inhabitants of *Hiso* (being a Village in the western part of the Island, and nearest to the Opening of the Mountain) were wholly covered by it; and afterwards followed a whole Stream of burning *Brimstone*, which consumed many that could not escape. Afterward the Inhabitants perceived, that a Part of the said Mountain was sunk down; and three or four Days after another Part; and so from time to time, until the burning Lake was become almost as great as half of the Island: Wherefore the Inhabitants went on board of their Vessels and Boats, from whence they perceived that huge great Pieces of the Mountain fell into this fiery Lake, as into a bottomless Pit, with a most prodigious Noise, as if a whole Cannon were discharged. But the most remarkable thing was, that the more vehement the Fire was, the lesser the Island was shaken. The Inhabitants of another Town called *Woroc*, upon the East-side of the Island, not thinking themselves in so great Danger, (the Opening, or fiery Lake being yet at some distance) remained a Month longer, until they saw the same continually approaching them. They observed that when great Pieces fell down, and that the Lake became wider, the Noise was so much the greater: so that they saw no likelihood, but that all the Island would be swallow'd up. Wherefore they unanimously transported themselves to *Banda*, leaving all their Moveables for want of Vessels, and arrived at *Amboyna* this 18th of *July* 1693.

Several burning Mountains have now been filled up and quenched; others have begun to open themselves, and cast out Fire, as in the *Isle-Chiaus*.

There is likewise a burning Mountain upon the Island *Celebes*: And in an infinite Number of Places, there is hot Water found, if you dig but 10 Foot deep.

An Account
of several
Burning
Mountains in
the Molucca
Islands, sent
to M. Nich.
Witsen; by
... n. 206.

P. 49.

In the Mountains of *Ternata*, is always heard a terrible Noise, as of the Crying of a great many People, caused by the Fires. It often casteth out Stones, and is probably exceeding deep; and the rather, because it is likely that the several burning Mountains of the *Molucca* Islands, are beneath consumed by the same Fire, which joineth the spacious Openings together.

The burning Mountain upon *Banda*, casteth forth a prodigious Quantity of Smoak and Ashes, oftentimes much Fire; and makes a Noise as if a great many of the greatest Cannon were heard all at once. This Mountain hath cast out so many Stones, (and some near six Foot long) that the adjacent Sea, which has been forty or fifty Fathom deep, is not only fill'd up there, but they become many Fathoms higher than the Water; whereby it may be conjectured, how large the inward Cavities of this Mountain are.

By—n.
216. p. 42.

2. After several vain Attempts, to search and examine the Constitution of the Opening of the Burning-Mountain, in the Isle of *Ternata*; at last, having passed thro' great Difficulties, and mounted very dangerous Precipices, we arrived at the Top, *Octob. 12. 1693*. When I first approached this terrible fire-vomiting Opening, wherein there is an inexpressible Noise, I could see nothing of the inward Parts, by reason of the Smoak: Wherefore I went back a little, tarrying for a better Opportunity. After some time, I found the Smoak very much diminish'd; and making haste to the Mouth of it, I saw the Opening which is underneath the North-side, from whence the Cavity extended itself towards the South, till the Edges, on both sides, came to terminate at the North-side of that which was fallen in: Wherefore we went towards the East-side, to look into the western Cavity; but we saw nothing but a fiery and flaming Substance, and the Conveyances of it. We did not venture to go to the North-side, to see into the South Cavities; not only because of the Southerly Wind, but also because 'tis like, that the most spacious *Antra* are on the South-side, which causeth the Smoak to be driven Northerly; and because we had formerly met with Pieces of burning Matter, that were cast out towards the North-side. Having seen enough, and satisfy'd my Curiosity, we withdrew, and returned to *Malayen*, bringing with us some Pieces of Branches of the fruitful *Clove-trees* that we had passed by.

The Northerly side of this burning Hole, is at the utmost Height of the Mountain to the Northward, or from *Hori*. To the West and Eastward of it there is, on each side, a Hill higher than the *Brinks* of this Hole, both of them grown over with *Reed* or *Cane*, by the Inhabitants call'd *Cannacanna*: The most westerly is situated more northerly from the Hole; on the South-side of this we got up. The most easterly, on the contrary part, lieth more backwards from it, and to the Southward of it. The Southerly Hill, on the West-side of the Mountain, turns about to the Eastward, with a Riff or Ridge, and terminates at the North-side of the Mountain. The Mouth of this fearful Hole, on the West and South-East sides, is surrounded, as by a Bank; each Bank having a several *Ditch*, and the Brink of the Mouth is upon the highest Part,

part descending on the Outside. The three Hillets nearest to the Hole are quite barren, and nothing but Stone ; but the most remote is covered with thick *Reeds*.

Round about the *Hole* lies scattered, much of the Matter that hath been cast forth ; and it is perceivable, that it must be soft when it comes out, because it falls flat, according to the Figure of the Place where it falls. The Colour of it is dark green, not clear, but somewhat grey ; and this Matter generally does burst, or separate itself as the Dung of a Cow. There are of this both great and small Pieces, now turned into Stone, being inwardly blackish, and spongy, mixt with white Spots : And to give you some further Particulars of this burning Mountain, I have observed, that the extreme or most southerly round Bank, is all covered with *Cannacanna* ; and it is the highest also. The *Smoak* which, in respect of *Malayen*, seemed to come forth out of a higher Place, now in the descending of the Mountain, doth notwithstanding seem to come forth at the same Height.

There is a barren *Hill*, that seems to be situated on the North-side of the *Top*, a little descending towards *Malayen*, but it is about the same Height as the highest *Top* that is seen from *Malayen*. Furthermore, the Reason why the *Smoak* seems to come forth from a higher Place, is because the *Opening* is more southerly ; and then in regard of only *Malayen*, it seems that the *Smoak* comes forth more towards the midst. Wherefore I do certainly believe, that the right *Opening* formerly has been where the round Banks now lie ; that is, to the Southward : For, whereas, after a good Space of violent Burning there groweth a small Bank ; any Person that should see the Situation, would be of my mind. And besides, it being 9 or 10 Years since the last Burning was perceived, there are to be seen round about the *Opening* (besides the Barrenness on both sides, which is some distance from the *Opening*, in descending towards the West and North-sides, as also above on the South and East-sides) Trees all about, of an equal Thickness, as all grown since that time, and now newly burst and burnt by the Fire.

Lastly, My Opinion is, that, altho the *Smoak* of it hath not been seen from below, the Fire nevertheless hath not discontinued ; because the inward *Noise* is so terrible, that any Person whosoever hears it, will judge with me, that it is a bottomless Pit of the vehementest Fire, which cannot be quenched while the World lasts. The Horror and Danger that one undergoes who will see this, is rather to be conceived by Thoughts, than expressed by Words.

3. Nov. 2. 1694. A very thick *Smoak* was seen about the Top of the Mount By —n.
Gowncng Apy, which was much augmented on the 21st and 22d, and that Night 228. p. 530.
the Flame broke out : On the 23d, 24th, and some following Days, the Fire was continually encreasing on the West-side, and with such Blows, as if the greatest Pieces of Cannon had been discharged : so that we were fearing that the whole Mountain should have been cast upon us. A Day of Humiliation and Prayer was proclaim'd by the Government against the 7th, throughout all Banda. Sometimes the Mount brought forth such a Noise, as the greatest Storms can do about the Rigging of a Ship, or a Building on Shore ; and afterwards followed Stones, on the West-side, as far as the Sea, which was a hor-

rible Spectacle. Fishermen have related to me, that so many Stones have been cast out already, that the Place where they used to fish with Lines at 40 Fathom Water, is now dry; and the Fire cometh out of the Water so vehemently, that it is dreadful to see, and the Water is so hot that we cannot come near it: And now the Mountain burneth most towards the Side of the *Loutoir*. The Trees on the East and West side are altogether spoil'd, and the West-side is covered with Stones God knoweth how high. The Stink of *Brimstone*, during the Westerly *Monsoon*, is so intolerable, that one could scarce endure it in the Streets of *Neira*, where it causeth a great Sickness. The Water which runneth down, is, by reason of the *Brimstone* and *Salt-Petre*, become sour, and without a natural Taste. The Gardens which were on the *Gownong Apy*, and formerly brought forth great Store of Fruits for Man's Livelihood, are partly covered with Stones, and partly desert. The greatest fear is, because it is *consum'd inwardly* towards the *old Hole*, which was blown up in the Year 1615; and because the Fire seemeth to take its Course towards the South-west, and that it being quite hollow there, will tumble inwardly, or be subverted.

By—ib.
P. 531.

4. The Mount *Gownong Apy* casteth out Stones round about the Mountain, and the Fire ascendeth so high, that we can see it above the High-land at *Denter*.

By—ib.
P. 532.

5. Mount *Gownong Apy* (burning continually) doth cast out so great a Quantity of Fire and Ashes, that the *Trees* of the Country *Neira*, and part of those on the high Country of *Loutoir*, is so much covered with Ashes, that not one good Fruit is to be expected from them.

By—ib.

6. At *Neira* there is neither *Leaf* nor *Herb*. The Ground is cover'd with *Stones* and *Ashes*; one half of the high Country is likewise in a sad Condition, many *Trees* are wholly or partly *dead*, and the rest *lingring*. There is not one House at *Neira* without Damage, several are quite demolished to the Ground by the Weight of the *Dust* and *Ashes*.

Those of *Denter*, *Weyer*, *Celam*, and the inward Coast, as far as *Walking*, have likewise a sad Experience of this Calamity. We are sometimes visited with *Earthquakes*; and especially May 11th 1695, about 2 a-clock in the Afternoon, we had 2 hard *Motions*.

By M. Nich.
Witzen, n.
228. p. 529.

7. The Mountain *Kemas*, or Brothers, in the Territory of *Manado*, is blown up with a most dreadful Noise, as of the hardest Thunder, which caused *Darkness* and an *Earthquake*, with very heavy Blows, and other dismal Signs at *Ternata*: Which Noise hath also been heard at *Amboyna*. The Mountain of *Brimstone* upon *Amboyna*, call'd *Wawany*, does also burn dreadfully.

From all which it seemeth evident, that in those Parts and Seas, there are *subterraneous Fires*, having a mutual *Communication* one with another: which God knoweth but may, at some time, cause the sudden *Subversion* of them, and consequently a notable Change, or Alteration of the World's Globe. Those who have seen these Things with their own Eyes, have told me, that when a Hole is made in the Ground 10 or 12 Foot deep, the Ground is warm.

XIV. 1. On the 19th of Jan. 166 $\frac{1}{2}$ at divers Places near Oxford, was observed a small *Earthquake* towards Evening. In Oxford itself, I do not hear that it was observed to be an *Earthquake*; yet I remember, about that time (whether precisely then or not, I cannot say) I took notice of some kind of odd Shaking or Heaveing, I observed in my Study, but did impute it to the going of Carts, or Coaches, supposed to be not far off; though yet I did take notice of it, as a little differing from what is usual on such Occasions, and wondered the more that I did not hear any: But not knowing what else to refer it to, I thought no more of it. And the like Account I have had from some others in Oxford, who yet did not think of an *Earthquake*, it being a rare thing with us.

An Earthquake near Oxford, 1665, by Dr. Wallis. n. 10. p. 166.

I find my Notes, concerning my *Thermoscope* and *Baroscope* for that Day to be these.

166 $\frac{1}{2}$. January.	Thermo.	Barosc.	Weather.
Day. Hour. Inches. Inches.			
19. 8. Morn.	14 $\frac{1}{2}$	29 $\frac{1}{2}$	Hard Frost. Close.
4. Even.	14 $\frac{1}{2}$	29 $\frac{1}{2}$	Hard Frost. Cloudy.
9. Even.	14 $\frac{1}{2}$	29 $\frac{1}{2}$	Rain. Wind.
20. 8. Morn.	15 $\frac{1}{4}$	28 $\frac{1}{4}$	Sunshine. Wind.

I hear, it was observed at *Blechington*, above 5 Miles to the North of Oxford, and so along by *Bostol*, *Horton*, *Stanton St. John's*, and so towards *Whately*, which is about 4 Miles Eastward from Oxford. Not at all these Places at the same time, but moving forwards from *Blechington* towards *Whately*: For it was at *Stanton* about 6 of the clock, or later (as I understood from Mr. Boyle, who was there at that time) but had been at *Blechington* a good while sooner. And I am told, that it was taken notice of by Dr. Holder, (a Member of our Society) who was then at *Blechington*, to be observed by those in the further part of the Garden, some very discernable time before it was observed by those in the House; creeping forward from the one place to the other.

2. Riding somewhat late betwixt Oxford and a Lodging I have at a place 4 Miles distant from it, I found the Cold very piercing, which put me upon galloping at no very lazy rate; and yet before I could get to my Lodgings, I found the Wind turned, and felt the Rain falling. This Accident, considering the shortness of the time, and that it was preceded by a settled Frost, was surprizing to me; being one of the greatest and suddenest Alterations of the Air, I had ever observed. Soon after (by my Guess about an Hour) there was a manifest Trembling in the House where I was, which stands high in comparison of Oxford: But it was not there so great, that I should have taken any notice of it as an *Earthquake*, if I had not been advertised of it, as being taken notice of by the People of the House. Soon after there happened

By Mr. Rob. Boyle, n. 11. p. 179.

pened a brisk Storm ; whereupon I sent to make Inquiry. at a place called *Brill*, which standing upon a much higher Ground, I supposed might be more obnoxious to the Effects of the *Earthquake*. The Person I sent to, writ me a Ticket ; whose Substance was, That the *Earthquake* there was much more considerable, than where I lodged ; and that a Gentleman's House in the Neighbourhood trembled very much, so as to make the Stones manifestly to move to and fro in the Parlour, to the great Amazement and Fright of all the Family. The Hill whereon this *Brill* stands, I have observed to be very well stored with mineral Substances of several kinds. I have been informed by others that this *Earthquake* reached a good many Miles.

By Dr. J.
Beale, n. 116.
P. 357.

3. I conceive the *subterraneous Steams* might be the Cause of such a *Mid-land Earthquake*. And I know no surer or better Way to find out the Nature and Properties of those Steams, than by observing the Effects, and all the Alterations of the Air, as Mr. Boyle and Dr. Wallis have done.

An Earth-
quake at
Oxford,
1683 ; by
Mr. Tho. Pi-
gott, n. 151.
P. 311.

XV. Sept. 17, 1683. An *Earthquake* happen'd here at *Oxford* : The Rarity of such Effects make many People not know what they are ; and by heightning their Surprize, imposes upon their Judgments. One fancied it to be the falling of something about his House ; another the tumbling of Wood ; a third the rattling of a Cart ; one, one thing, and one another, till either a mature Deliberation, or Intelligence from other Hands, convinced them to the contrary, and satisfy'd them it was an *Earthquake* : Besides, the short Continuance of the Trembling, would hardly permit them to make any accurate Observation.

I, for my part, perceived the *Sound* and *Motion* very plainly ; and though when I saw the Clearness of the Morning, I judged that to be an *Earthquake*, which otherwise I might have thought to have been only a distant Thunder, yet had I not so clear an Impression of it in my Mind, as to make any considerable Observations of my own : So that what I can afford you, will be only some occasional Reflections upon *Earthquakes* in general : and Remarks upon the Intelligence which I have picked up here and there, concerning this in particular.

1. This *Earthquake* happened at a time, in which such Effects are commonly experienc'd, if we may credit *Aristotle*, who tells us, That they are most frequently, tho not always, in *Spring* and *Autumn* ; in which there is generally a greater Abundance of *Moisture* sucked up, more *Vapours*, and a larger Quantity of *Nitre*, (as Experience doth demonstrate) all which Ingredients may conspire to the producing of an *Earthquake* : For if we consider how capable they are of a large *Expansion*, how forcible they are when rarefy'd in Vessels, closed and placed over the Fire ; in *Æolipyles*, from which they break out with forcible Blasts, or in Winds, which frequently proceed from the *Rarefaction* of such Principles ; we may suppose that those *Vapours* which produce such great Commotions in the Air, may cause a considerable Disturbance in the *Earth*, when pent and locked up by Cold, or any such like Accident.

2. The

2. The latter part of the first Week in *September* was so rainy, that most People were apprehensive of a Flood, and upon *Sunday* the 9th of *September*, there fell some very considerable Showers in the Afternoon; but from that time it cleared up, and to the End of the next Week, continued very warm and pleasant Weather. The Evening of *Sunday* the 16th, was inclinable to Frost, and the next Morning it was found to be a very hard Frost, for the Season; and then about Seven of the clock, the Day being very Clear and Calm, the *Earthquake* happen'd. The like Observations of Cold preceding that of 1665 were made by Dr. *Wallis* and Mr. *Boyle*.

3. The Quick-silver in the *Barometer* (as I am told by the Operator in *Chymistry* here) stood as high then as at any time these three Years; which, together with a remarkable Calmness of the Air, a matter generally looked upon as one of the Circumstances which accompany *Earthquakes*, and by many reckon'd among the Signs which fore-run them, may be sufficient to shew how free the Air was from Vapours at that time; and surely the fewer there were above, the more may be supposed below.

4. *Ignes Fatui* were frequently seen a few Days before this *Earthquake* happen'd; which may pass for a probable Argument, at least, to shew how full the *Earth* was then of *Damps* and *Exhalations*, since a *Stench* that hath tainted Well-water after an unusual manner, hath upon the same account been generally reckon'd amongst the Signs of an *Earthquake*, by which it may be predicted: For by this it was that *Pherecydes* is said to have presaged the *Earthquake* of *Lacedæmon*, and *Helmont* mentions another who pretended to the same Fore-sight, by tasting the Water of a very deep Well in the Castle of *Lovain*.

5. The Motion of this *Earthquake* was not of that sort, which are termed *Pulses* or *Succussions*; such 'as strike the Ground at right Angles with a violent Shock, or intermittent Knocking, so as oftentimes to raise the *Earth* to a considerable height, or force their way by a breach: but it appear'd rather to be such a trembling Motion as vibrates and shakes without altering the Position of the *Earth*, and leaves all things in the same Posture in which it found them. For it shook the *Earth* with a *Tremulous* and *Vibrating Motion*, whose Reciprocations were repeated with a great deal of Quickness. The *Pulses* were, as I could perceive, a little discontinued, and yet they came so thick that I could not count them, tho' the whole *Earthquake* continued here scarce more than 6 *Seconds* of Time; and when that ended, the *Motus Restitutionis*, or settling of the Building in which I was, did seem to be with a Crash.

6. Now as *Tremulous* and *Vibrating Motions* are proper to produce Sounds, so was this *Earthquake* accompanied with a hollow *Murmuring* Sound, like distant Thunder, as I have observed before, which Sound kept time so exactly with the Motion, and was so conformable to it in all respects, that it plainly appears there was the same Reason for both. To those that were within doors it appeared to be more considerable, and as it were in the Air above, occasioned chiefly by the shaking of the Building; as we may guess by a Blow or Stamp in a Room, which besides the principal Sound from the

the part which is stricken, causes another obscure one, together with a small Shaking throughout the whole; and in the *Laboratory* it was heard more loud: For all Sounds have a great advantage there. But those who were abroad in the Fields and open Air, perceived with a gentle Shaking, a hollow Murmur towards the Surface of the *Earth*, not unfitly compared to the Groaning of some Planks of Elm, Ash or Firr, when the Application of Fire causes both a Trembling and Sound. That there is a considerable Heat within the *Earth*, is manifest from the Experience of Mines working in the deeper Grooves; from those hot Springs which break out thence, from Fermentations occasioned by Mineral Spirits. Nor is it less commonly observed, that such *Heats* and *Fermentations* within the *Earth* are augmented by Frosty *Weather*, when the Steams being more pent up and hindered from breaking out, do work more forcibly upon one another. And that Sounds and Tremblings may be produced by such *Heat*, though it did but work upon *Air*, *Watery Vapours*, or *Nitre*, only included in Pores and Cavities, appears by several Experiments; as that of filling Glass-bubbles half full with *Water* and *Nitre*, which being set to the *Heat* of the Fire will tremble with a sort of humming Sound, and after that break with a great deal of Noise and Violence.

7. This Sound as well as Trembling appears to have been the same in most of those places where they were perceived; from whence we may infer, that they were not caused by the falling of the *Earth* or *Rock* from the upper part of some Cavern; nor from any Commotion of Vapours within the Hollows, as Powder works in a Mine, by which Similitudes it is usual to expound some *Earthquakes*: For then it would have been perceived more plainly in places above it, or those that were near adjoining, and not equally considerable in Towns of such various distances, as *Oxford*, *Burford*, *Watlington*, *Benson*, *Brill*, and *Ailsbury* in *Bucks*; *Wallingford*, *Radley*, *Appleton*, and some other places in *Berkshire*; with many more round about.

8. Yet I cannot but say that it was less considerable in some places than in others: the Men of some Towns speak dubiously, especially towards the North of *Oxford*; and some talk of a neighbouring Town feeling it, tho' their own did not. Yea, even here in Town the *Earthquake* was not perceived so plainly in some places as in others; but that may depend upon Circumstances, as the Position and Form of the Houses, or some Accidents, as Noise and Carts intervening, which might render it less observable. Besides, I do not deny but there may be some *Cuniculi*, little Passages or Hollows here and there under ground, which might advantage the Trembling, and elsewhere more solid Parts which might damp and obstruct it.

9. This might occasion some Difference in the Sound too. One perceived it like a Voice under Ground, but he could not tell which way it passed, perhaps there might be a Cavern there. Another who was travelling over *Shotover* heard the same; and it is very likely that there are considerable Hollows there. One who was fishing in the *Charwel* informs me, that whilst his Boat trembled under him, and the lesser Fishes seemed much af-
frighted,

frighted, by an unusual skipping, he heard the Murmur, as of a rising Wind, which he fancied just then breaking out, and rumbling upwards, but felt none. The like Relation, as to rumbling in the Air, I have from good Hands, concerning some People that were in *Dourton-Park* in *Buckinghamshire*; which I mention only for the Distance sake: for most hereabouts agree in the same Fancy. I myself heard it like a distant Thunder; a Noise determined to one Place, not fleeting or passing from me; though the Crash which ended the shaking of the Building, little deceived me in my first Imaginations.

Aristotle (*de Mundo*) calls the *Earthquakes* of this kind, by the Name of *Bojavit*, as if they boiled, because they ply up and down. And I take this that happened here, to be no such forcible or irregular Ebullition, raising the *Earth* with intermitting Shocks, as that of *Mechlin*, for instance, *Apr.* 4. 1640, described by *Van Helmont*; but a regular *Effervescence* of inclosed Vapours, more evenly dispersed, working up and down the *Earth*, with a trembling of each Part, and a reciprocal Agitation of the Whole. For I could never meet with any, who pretended to determine from what this *Earthquake* came, or whither it went.

10. All who felt this *Earthquake*, say, it happened about 7 a-clock; but I dare make no inference from hence, that the shaking really was in all Places at the same time, unless the time had been exactly observed to a Minute, at least, in several Places. For since all Tremors and Sounds are found to move above 15 Miles in a Minute, and above 94 in an Hour; and consequently the Trembling of the *Earth*, passing along with a continued Noise, may be supposed as quick in its Motion; it might, according to this Calculation, in a minute's time, have reach'd the Extremity of its Sphere or Compass: For the Circuit of this *Earthquake* was but 70 Miles, or thereabouts; its largest Extent was from South-East to North-West; the least, from N. to S. For it was perceived a little short of *Kirlington N.* of *Oxford*; at *Blechington*, and at *Ailsbury S. E.* where it was perceived plainly; as also at *Thame*, which is *E.* and so at *Aston*, *Kingston*, and *Stoken-Church-Hill*; at *Watlington S. E.* (some say at *Reading*, which is more S. and then its Compass may be supposed larger) at *Wallingford S. E. b. S.* as much as any Place; at *Abingdon S.* but not so much; not so far as *Farington S. W.* but at *Bampton W.* at *Burford* to the North; at *Lo. Harborough N. W.* not much; at *Woodstock*, which is more N. little or none; and at *Glympton*, 2 Miles beyond it, not at all, as I am inform'd. But this is a very inconsiderable Space, if compared with that which happened in the Southern Parts of *Norway*, *Apr.* 24. 1657. and took up 160 Miles in Length, and so much in Breadth, saith *Michael Peterson Escholt*, that describes it, and *Kircher* mentions one 200 Miles in Length.

11. The Effects too of this *Earthquake* were very inconsiderable; as shaking down some Pewter, in a very few Places; casting out a Truckle-Bed Westward; which, when I looked upon, I found so very easy to move, and apt to run, as also the Room so smooth, and declining towards that Point, that I could as little infer from thence, that the Motion came this or that Way, as from the falling of many Books from the North-side of a Warehouse,

house, when a few only fell from the South. And of whatever nature the enclosed Vapours were, which caused this *Earthquake*, it seems as if they were not able to force their Passage through the *Earth* (at least but slowly :) For the Air, till the End of the Week, continued fair; tho' the Week ensuing was very windy and boisterous.

12. We have *Earthquakes* here very seldom; not one before for almost a Score of Years, except that which is doubtfully reported to have happened about four a-clock in the same Morning. But seeing the *Earth* abounds with such great Variety of Matter, which may produce them, as also with so many Caverns and Chinks of such various Figures, through which they may be agitated with such different Motions, it seems more easy to shew how they may begin, how they may be carried on, how they may produce such different Effects, and how they may continue; than to determine why they should happen so rarely, do no more Mischief, or be stopped so soon in their Motion.

An Earthquake in the Mid-land Counties, 1683. By Mr. Tho. Pigot. n. 151. p. 321.

XVI. There was another *Earthquake* far more considerable, which happened Oct. 9. about 11 at Night, and was in *Oxfordshire*, Northwards, very much; some say, they felt it here at *Oxford*. It spread all over the *Mid-land Counties*, and extended into *Derbyshire*; in which, as in the Coal-Countries, it was very violent. They report, that it was in all its several Places at the same time, not determining precisely, and that it produced some remarkable Effects.

An Earthquake in Sicily, 1692-3. By Mr. Martin Hartop. n. 202. p. 827.

XVII. 1. It seems highly probable, that these Tremblings of the *Earth* proceed from the same incens'd Matter, which finding a Way at other times thro' the *Mongibello*, has so furiously broken out in Smoak and Fire. This appears by the Tragedy of *Catanea*.

The Eruptions of these Mountains are of two sorts: the one not so very violent, as to disturb much the adjacent Country; and this happens once in 2 or three Months, and lasts 3 or 4 Days: The other is more furious, and of longer continuance; and is observed here at *Naples*, to happen to Mount *Vesuvio*, once in about 80 Years, as I heard the ingenious Mr. *Peccacio* say. Of these, the last in 1632, was so very violent, that, by the best of his Observation, it cast the Rocks 3 Miles into the Air. Now from the burning or not burning of this Hill, *Naples* (and without doubt the same holds in *Sicily*) calculates its Safety or Danger of *Earthquakes*: For without doubt, the Matter is continually burning under the Mountain; and those vast Clouds of Smoak, which daily issue out of the Top, if the Cavity happen, by any Rock, or inward Alteration, to be stop'd, must deviate through other Passages under ground, heaping up continually Magazines, for a future Calamity. Now this combustible Matter seems to me to be nothing but *Nitre*, mixed with some other Minerals and *Sulphur*. He that has seen the Way of making *Salt* of *Tartar* by *Deflagration*, where you mix an equal Quantity of pulverized *Nitre*, has seen an exact Type of these burning Hills; for after each Spoonful you put into the burning Crucible, arises first a black thick Smoak,

Smoak, after which the fired Mineral boils up, as if it would over-run the Top of the Crucible.

The Motion of the *Earth* is not from the *Perpendicular*, but *Horizontal*; as appears by the Cracks in the *Earth*, which, they say, are to be found now all over *Sicily*: 'Tis a Vibration so quick, that it cracks the Glafs in the Windows; 'tis disputable, whether the *Reciprocations* of a Lute-String are more frequent. Now when the *Vibrations* are so quick, and the Body moved, so great, the Motion must be prodigiously violent. We observe, that *Thunder*, which is the Effect of the Trembling of the Air, caused by the same Vapours dispersed thro' it, encountring one the other, has force enough to shake our Houses. And why there mayn't be Lightning and *Thunder* under Ground, in some vast Repositories there, I see no Reason; especially if we reflect, that the Matter which composes the noisy Vapour above us, is in much larger Quantities to be found under Ground. I can attribute this *Horizontal Trembling* to nothing else, but the furious Passage of the incens'd Matter, from one Grotto to another: For 'tis very probable, these are continued, in some Parts of the *Earth*, for several Leagues together; witness your last *Earthquake*, about 4 or 5 Years ago; which was felt (with little difference, as to Time) in *England* and *Ireland*. Another Confirmation of this, is, the Manner how these trembling Fits are performed; which is not all of a sudden, like that of *Gun-powder* in a *Mine*; but is small at first, afterwards gradually more terrible, like a growing *Tempest*. A third may be, the Observation of some here in *Naples*; That when Mount *Vesuvio* ceases to burn, the *Sulfaterra* sends out its Fumes more violently; & vice versa. Now this *Sulfaterra* is a Hill near *Puzzolo*, as distant from *Naples* on the one hand, as the Hill *Vesuvio* is on the other; so that 'tis more than probable, that *Naples* stands upon a burning Arch, thro' which, as a Pipe, there two furious Neighbours do reciprocally receive the above-said *Exhalation*. This seems to me a growing Evil to this wealthy and populous City; and what may possibly make good the Prediction of *Sanazarius*, who was born here:

Et te, quis putet hac? Altrix mea, durus Arator
Vertet: & Urbs, dicet, hac quoque clara fuit.

2. The Island of *Sicilia*, of 700 Miles Circuit, and divided into 3 Valleys, By P. Alessandro Burgo, ib. p. 830. began on *Friday* the 19th of *January*, 1693, about half an Hour past 4 a-clock, to be sensible of the Shake, in the Valley of *Mazara*: But in the two other Valleys of *Emone* and *Noto*, the *Shakes* were so terrible, as to throw down some Buildings, obliging the Inhabitants to seek Refuge, either in the Fields, or with Prayers and Tears implore the Divine Pity in the Churches. On *Sunday* following, being the 11th of the same Month, at 20 Hours and 3 Quarters, the Hand of God appeared much more terrible, awakening the most lethargick Sinner. The *Shakes* of this *Earthquake* did no damage in the Valley of *Mazara*, only frightening of the People.

Palermo received some Detriment in most of the Buildings; especially the Palace and Hospital of *St. Bartholomew*; the Steeple of *St. Nicholas*, belonging to the *Augustines*, was ruined, and some Hurt done to the Church: but little Mischief else done, and no body hurt.

In *Messina*, all the Buildings of the *Theatre* are shatter'd; the Royal, and Archbishop's Palace, with the Seminary, are all cracked. The vast and stately Church of the *Franciscans* broken in many Places, and the Roof of the *Vestry* fallen; the Steeple of the Church of the *Annunciation* thrown down, with the Death of the Sexton; the Top of the Spire of the *Dome* cleft: Many private Buildings were thrown down, and all the rest shored up; there were but few Persons killed.

Troina, *Randazzo*, *Nicosia*, Cities in the Mountains, suffered in their Buildings. The first, and half of the Mother-Church destroyed, with the Parish-Church of *St. Lucy*, and was much damaged in its Monasteries; one whereof is not habitable: The last had its *Dome* very much hurt. *Castiglione* had the Castle and many Houses thrown down: In *Franca Villa* and *Linguagrossa*, the greater Part of the Buildings, and some Churches: *Mascali* quite ruined, but not many killed; most of the People being abroad, at a Procession with the Reliques of *St. Leonard* their Protector.

Aidone received a considerable Mischief; two whole Quarters, with many of its Inhabitants, being destroyed: In the Quarter of *St. Laurence* there is not one House standing, and the Churches ruined: In that of *St. James*, the Church of the *Annunciation* and its *Oratory* thrown down, with several other sacred Edifices. In the other Part of the City, which stands lower, there were not so many Houses nor Persons lost; yet the Church of *Pope Leo* is quite flat, and the magnificent Church of the *Dominicans* in Ruins, with the Convent of the *Reformati Osservanti*, one of the best in the whole Province.

Abi Aquilea, commonly called *Jaci Reale*, situated at the Foot of *Ætna*, is almost quite destroyed, and its Inhabitants buried in the Ruins, with many Convents; amongst the rest, the famous one of the *Osservanti Reformati*.

Aci St. Antonio, *Aci St. Filippo*, *St. Gregorio*, *Pedara Trecazzani*, *Bonnacorei*, *Nicolosi*, *Motta*, *Mestebianco*, *Fenicia*, and several other fruitful Villages, situated near *Mongibello*, are destroyed, with all the Habitations of pleasant Hills about *Catanea*, which are now in the Dust.

Paterno, about 12 Miles from *Catanea*, a populous City, at the Foot of *Mongibello*, lost most of its Buildings, all the Convents of Fryars, and a very fine Monastery: In the Ruins were buried 40 Persons. *Aderno* had the same Fate.

Cantabiano Piemonte, in the Valley of *Etna*, *Francofonte*, *Palagonia*, in the Valley of *Noto*, are little less than wholly level'd, and about 300 Persons destroyed. The Marquis of *Francofonte* was miraculously saved, by leaping out through the Crack in the Wall of the falling Edifice:

Catanea, one of the most ancient and famous Cities of the whole Kingdom, honoured by the Courts of several Monarchs, and an Episcopal See, even from the Times of the Apostles, giving place to none, in the Beauty of its sacred Edifices; amongst which, the *Dome* was the most sumptuous and large

large in all *Sicily*, adorned with excellent Pictures, and richly furnished, and blessed with the Reliques of the invincible Martyr *St. Agatha*, honoured with the Bodies of several Kings; besides, it had a very high and curiously built *Steeple*. Here were a great many Nunneries; amongst the rest, the Monastery of the *Trinity*, and that of *St. Benedict*, with that Prodigy of Workmanship, the magnificent Monastery of *St. Nicholas*, with its Temple; a Place famous for several Reliques. Next, the *Jesuits* College, the Convent of the *Minorites*, and two of the *Dominicans*; the beautiful one of *Capuchins*, the Imperial Convent of the *Carmelites*, that of the *Reformed Minorites*, that of the *Reformed Augustines*, with several other Friaries, with an infinite Number of the antient and modern Churches, Colleges, and other publick Buildings, inhabited with 23000 Souls.

Its Nobility, many and antient: Learning was here in its Glory; the Citizens were themselves learned, and Lovers of Knowledge, assisted with the many Privileges granted by the King. The University, where the learned Laurel was conferred on the Worthy, made this Place the *Sicilian Athens*. This once so famous, now unhappy *Catanea*, had the greatest share in this Tragedy. Father *Antonio Serrovita*, who was to preach at *Catanea* the Lent following, was on his way thither, on the 11th, at 20 Hours and $\frac{1}{2}$, and at the distance of a few Miles he observed a black Cloud, like Night, hovering over the City; that there arose from the Mouth of *Mongibello*, great Spires of Flame, which spread themselves all round; that the Sea, all of a sudden, began to roar, and rise itself in swelling Billows; that there was a very great and dreadful Blow, as if all the Artillery in the World had been at once discharged; that the Birds flew about astonish'd in the Air; that the Beasts and Cattle in the Fields ran crying about, affrighted; that his, and his Companions Horses were so startled, that they stood stock still, trembling so as that they were forced to alight; which they had no sooner done, but they were lifted from the Ground above two *Palmes*; and casting his Eyes towards *Catanea*, he with amazement saw nothing but a very thick Cloud of Dust in the Air. This was the Scene of their Calamity. For of the magnificent *Catanea*, there is not the least Footstep to be seen. All its Edifices are levelled with the Ground, except the Chappel of *St. Agatha*, the *Rotunda*, the Castle of *Ursino*, the Walls that encompassed it, and a few mean Houses. There was a very great Destruction of the Inhabitants, buried in the Ruins of the Bishop's Palace, the Steeple, and *Dome*, where most of the City, frightened with *Friday's Earthquake*, were got together, to carry the Reliques of *St. Agatha* in Procession. Many of the Nobility were saved under the Chappel of the Saint, and some of the Clergy: The Number of the Dead were about 15000; for though the People had staid in the Fields all the *Saturday*, yet the Solemnity obliged them to be in the City on the *Sunday*, to pay their Devotions, at the Procession. Of the *Benedictines*, about 25 were killed in the Quire; of the *Jesuits*, 21; of the *Conventuals*, 11; the Number of the *Dominicans* is not known; the *Carmelites* were all buried, except one, as they went in Procession; and so were the greater part of the other Religious Orders; and of the Nuns, few were saved. This was the Tragedy of

Catanea; which was accompanied with dreadful Lightnings and Thunder from Heaven, with Deluges of Rain; and in the Ruins were heard nothing but Cries, Shrieks, and dying Groans. On the Heaps of Stones, we may now write, *Here was Catanea*.

Lentini, a very antient City, honoured with the Births of many illustrious Persons, amongst the rest, that Father of Eloquence, *Gregorio Leontino*; of a long time an Episcopal See, &c. felt that Shock on the 9th, with such Violence, as threw down and ruined the greater Part of its Buildings: amongst which, was the antient Convent of *Minorites*, famous for being the Dwelling-place of *St. Anthony of Padua*; the *Royal Convent*, so called, from the Tomb of one of our Queens, buried there; under the Ruins of which, four Religious were buried; the rest escaped miraculously. But the last *Earthquake* on the 11th, laid in the Dust the Remainder of the City, with the Death of about 4000 People, that return'd thither after the first Shake, to take care of their Goods: So that now there is but the Carcase of a City, all shatter'd to pieces, not one House left standing.

Carlentine, a modern City, being as a Citadel dependent on *Lentini*, had the same Fate. The beautiful Castle of *Licodia* all ruined, with the Marchioness of *Martini* and all her Children buried therein.

Bizzrini, a City of rich Inhabitants, is levelled with the Ground.

Sortino and *Cassero* are quite demolished; in the first about 300 perished.

Agosta, a trading Town, built on an Island, in a large Bay, which makes a capacious Port, was all blown up into the Air; for besides the Damage of the *Earthquake*, there was a great Quantity of Powder in the Castle, that took fire, and killed several of the Citizens, that had escaped into the Fields, with the Stones of the Buildings. Here perished about 3000. The enraged Sea grew terribly boisterous, and tempestuously beat against the Walls of the *Dominican Convent* with such fury, that some Galleys, belonging to the *Knights of Malta*, scarcely escaped Shipwreck in the Port. In fine,

Luclus ubique, Pavor, & plurima Mortis Imago.

The Country of *Mililli*, in the Dutchy of *Montalto*, felt the same Fate, with the Destruction of the Inhabitants.

Syracusa, famous in old time, an Episcopal See; in our time, like the *Phoenix* arising from the Ashes, standing upon a *Peninsula*, by Art made an Island, having a Bridge to the main Land; strengthened with a modern Fortification, sufficiently populous, by reason of its convenient Situation for Trade, full of Nobility, and beautified with Churches, Convents, Monasteries, and Palaces, now mourns in Ruins. It was sensible of *Friday's*, but shook to pieces by the *Sunday's Earthquake*, with the Loss of many thousand Persons. Most of the Nobility saved themselves by a timely Flight. Of the Religious, not many perished. Scarce a Village in the whole Diocess is left; Confusion reigns every where: and the Misery is increased, by want of Food, caused by the Granaries and Mills being destroyed.

Laferla,

Laferla, Palazzuolo, and Bassei lie in Ruins, with many Inhabitants destroyed.

Spacaformo, a populous Place, situated near the Sea, which washes the Foot of the Promontory *Pachino*, has lost all its Buildings. Here they reckon about 2000 dead.

Giarratana with its Fall killed most of its Inhabitants : The Marquis himself, with his Wife and 3 Children, escaping on *Friday*, were, on *Sunday*, buried in the Ruins ; the Marquis and his Children were taken out alive, to bewail the Loss of his Lady.

Melitello, in the Valley of *Noto*, is shaken to pieces ; the Churches and chief Buildings even with the Ground, and the Religious Orders all turned out into the open Air, or under Huts and Cabins.

Occhiula escaped not the common Calamity.

Mineo, an ancient City, is now no more ; and the greater part of the Citizens and Religious.

Caltagirone, a City conspicuous for its Senate and Nobility, suffer'd in this universal Calamity, the total Ruin of its proud Edifices : As the principal Church, with its very high Steeple, or Spire ; the famous College of *St. Julian*, the Temple of *St. George*, the Parish-Church of *St. James*, admired for the Pictures of *Epiphanius*, the Chappel only remaining, with the Image and Reliques of the Saint. The Temples of the *Conventuals* thrown down, the famous Bridge that joins the Convent to the Town shatter'd to pieces, and the Dormitories not to be inhabited ; the famous Convent of *St. Bonaventure*, the Fall of whose Temple and Spire, was the Destruction of the lower Buildings ; the College of the *Jesuits*, and the Steeple of that noble Church are quite ruined. The *Carmelites*, *Dominicans*, *Augustines*, *Crouched-Fryars*, &c. are all without Churches and Convents. The Monasteries of *St. Gregory*, *St. Chiara*, *St. Salvator*, and *St. Stephen*, with a *Conservatory of Orphans*, are all shook down. In fine, the Senate-House, adorned with most curious Statues, and all the other Buildings, are either fallen, or threaten a sudden Ruin. In these Desolations, about 1000 People were lost.

Modica, a populous Place, and a Chief of the Seignior of the *Admiral of Castile*, has its Buildings and famous Castle laid in the Dust. Seignior *Abbot Frederick*, the *Procurator General*, saved himself in the College of the *Jesuits*, from whom we had the Account ; and that the Cities of *Ragusa*, *Sicily*, and *Chiaramonte*, had the same Misfortune.

Comiso suffer'd much in its Buildings, tho' but few were kill'd : The Convent is down, but the Church stands.

Noto, an ancient and ingenious City, full of Nobility and fine Buildings, Convents and Monasteries, as we hear from a Courier from thence, is all ruined : the Convents of the *Dominicans*, *Conventuals*, *Reformati*, *Carmelites*, and *Capuchins*, which was indeed a wonderous Fabrick, are all torn to pieces. The Church of the *Crucifixion*, the *Dome*, and all the Nunneries are down, with the Deaths of many Citizens and Nobles.

To conclude, there is not a Corner in all the Valley of *Noto*, that is not ruined wholly, or for the most part, with a dreadful Slaughter of the People:

People. The Southern Coasts, as *Licati*, *Terra Nova*, and *Gircati*, have suffered Damage in their Buildings : And all the Castles of the Valley of *Emone*, near *Mongibello*, are crack'd and broken, or thrown down.

By the Noble Vincentius Bonajutus n. 207. p. 2. 3. The continual fiery Eruptions of *Ætna* (of which, the first that we have any account of, happened 500 Years before the Destruction of *Troy*, as *Diodorus Siculus* relates) have been taken for the most likely Causes of the horrible Shakes, that from time to time have laid waste the Island of

In Dec. 1. l. 1. Sicilia ; as is observed by *Fazello*, where he remembers that of the Year 1542, which on the 10th of *December*, at the 23d Hour, shook the whole Island ; and especially *Val di Noto*, *Syracusa*, *Lentini*, *Sortini*, *Mililli*, *Catanea*, *Agosta*, *Noto*, *Caltagirone*, *Melitello* ; and in short, the same Cities and Castles which were miserably ruined by the two late violent *Earthquakes* of this present Year 1693.

The first of which was at 5 a-clock, the next Night after the 9th of *January* : Its Motion was of that sort which *Aristotle* and *Pliny* call the first Species, and is by them likened to the shaking Fit of an *Ague*, causing such a Motion, as shakes the *Earth* from side to side. In this first, almost all the Edifices in the Country were throwndown ; where of some were very high, and strong-built Towers. A great part of the City of *Catanea*, with many others, were demolished, and a great many Buildings in *Val di Noto* ; *Syracusa* was also much shatter'd, but not ruined. This was not preceded by any Darkness in the Air, but a pleasing, serene, warm time ; which was the more observable, as being unusual at that time of the Year : yet it was not to any Excess.

Some Persons, which the Evening before were travelling in the Country, observed a great Flame or Light, at about an *Italian Mile's* distance, and so bright, that they took it for a real Fire, made by some of the Country People ; and though they went directly towards it, yet it seem'd to keep at the same distance from them. Whilst they were observing this Appearance, the *Earthquake* began, which was sensible even to the Horses they rode upon, that were affrighted thereat, and the Trees were all shaken. Upon this, the amazed Travellers looking for the Light they saw just before, found it quite vanished. We perceiv'd turning towards the Sea, that the Waves, which before the Shake only beat gently upon the Shore, began now to make a dreadful noise. The next Day, which was the 10th, the Night and Day following, the Air was overshadowed with Darkness, and tinged with a deep Yellow ; and the obscured *Sun* struck our Minds with a melancholy Preface of the approaching *Earthquake* ; which was the 2d, and happened on the 11th of the same *January*, about the 21st Hour, and lasted about 4 Minutes. It was much like the 2d Sort, which *Aristotle* and *Pliny* call a *Pulse*, or *Stroke*, for its resemblance to the beating of an Artery : and by *Possidonius*, in *Seneca*, is represented by the Name of *Vibrations*, it being a perpendicular lifting up of the *Earth*. Its Impulse was so vehement and powerful, that not only many Cities and Countries of the Kingdom of *Naples*, but the Island of *Malta* participated also of its Fury. It was in this Country impossible to keep upon our Legs, or in one Place, on the dancing *Earth* ; nay, those

those that lay along on the Ground, were tossed from side to side, as if on a rolling Billow.

In open Places, the *Sea* sunk down considerably; and in the same Proportion in the Ports and inclosed Bays: and the Water bubbled up all along the Shore.

The *Earth* opened in several Places in very long Clefts; some an Hand's Breadth, others half a Palm, others like great Gulphs. From these Openings that were in the Valleys, such a Quantity of Water sprung forth, as overflowed a great Space of Ground, which, to those that were near it, had a sensible *fulphureous Smell*, though in a low Degree, and without that unpleasant Stifling produced by the Smoak of *Brimstone*.

In the Plain of *Catanea*, an open Place, it is reported, that from one of these Clefts, narrow, but very long, and about 4 Miles off the *Sea*, the Water was thrown forth altogether as *salt* as that of the *Sea*.

In the City of *Noto* is a Street of half a Mile long, built of Stone, which at present is settled into the Ground, and quite hanging on one side, like a Wall that inclines; and in another Street, before the *Assent del Durbo*, is an Opening big enough to swallow a Man and Horse.

Great Rocks were loosened, and thrown down from the Mountains every where: And in the Country of *Sotino*, inhabited by about 5000 Persons, a great number perished in the Houses which were beaten down by them in their way, as they rolled down from the Hills. A great Cistern, or Reservoir of Water, hollowed on the top of a Rock, was loosened and thrown off from the rest of the Rocks, and slid down to the bed of the River that runs in the bottom; where the Cistern remains as it was, full of the same Water it had received before the *Earthquake*.

A very great many *Grotto's*, made by Art or Nature, are now fallen in.

In *Syracusa*, and other Places near the *Sea*, the Waters in many *Wells*, which at first were *salt*, are become *fresh*, and have not as yet lost their Goodness; so they are still fit to drink.

The Fountain *Arethusa*, for the space of some Months, was so brackish, that the *Syracusans* could make no use of it; and now, that it is grown sweeter, its Spring is increased to near double.

In the City of *Termini*, all the running Waters are dried up; and, amongst the rest, a small River near to it, with which they watered their Gardens and Orchards. It was contrary to the *Hot Baths*, which were augmented by a 3d part of what they were before the *Earthquake*.

In many plain and level Places, very high Walls leaped from their Foundations above two Paces, leaving that whole Space perfectly clear and free from Rubbish and Ruins, as if they had been taken up, and carried off. And in *Syracuse*, two Side-Walls of a small House, jumped up from each other; the one upright, and stood upon its bottom, at a great distance from its former Place; and the other, leaving its Companion, flew away so as to make an Angle with the other, to the wonder of the Beholders of so extravagant an Accident. Not far from the Country of *Cassaro*, from the tops of 2 Mountains, between which, through a long Valley, ran a River, two very great Rocks were loosened, which tumbling down over against each.

each other, met so exactly as to close up the Valley, and stop the Current of the River; which not finding any *Subterraneons* or Side-Passage, has fill'd up the Valley to the Top of the Rocks that were thrown down, and runs over them, forming a Lake 3 Miles round, of a considerable Depth.

In the Territory of *Sortini*, in a Piece of Ground half a Mile long, but much narrower; the Ground, at several little Interstices, is sunk from the Level in some places two, in other three *Palms*, and ends in a very deep circular Gulf or Swallow.

A Fountain, in the very Minute of the *Earthquake* on the 11th, threw forth its Waters tinged of a Blood-red, which continued for 3 Hours, and then it dried up, leaving many Holes in the Mud at the Bottom, through which real Ashes were thrown out; and the next Day the Waters returned of the former Quality, without the least Alteration.

In the City, encompassed with Caves on three sides, altho' by the considerable Shakes that were given it, there was not much Ruin made; yet a very dreadful Sound and Noise was heard for a great while.

The South Winds have blown very much, which still have been impetuous in the most sensible *Earthquakes*, and the like has happened at other times.

From the 11th of *Jan.* to this 14th of *Sept.* there have been considerable and strong South Winds, preceded by a Noise like Cannon at a great distance; some of a longer, some of a shorter Continuance: This has been observed in all Parts, but louder in cavernous Places, and in the Valleys between the Mountains; where the Shakes were more violent, in proportion to the Distance from the Sea.

Darkness and Obscurity of the Air has always been over us, but still inferior to that on the 10th and 11th of *Jan.* and often these Clouds have been thin and light, and of a great Extent; such as Authors call *Rare Nubecula*. The Sun often, and the Moon always obscured, at the Rising and Setting; and the Horizon all day long dusty; so that our wonted Prospects are shortened; but, for some little time past, it has grown something clearer.

The Heat, at the beginning of Summer, was not extreme; but the Sun entering *Virgo*, it grew very great, and at Noons intolerable.

Since the first of *August*, which was a most tempestuous Day, not only for the excessive Rains, for about 4 Hours, but for the Hail, and very loud Thunder, the Shakes of the *Earthquake* have been less sensible, and seldomer, and for two Months, not so universal; but sometimes in one Place, sometimes in another.

It has been observed, that in less solid Ground, such as Chalk, Sand, or loose Earth, the Mischief was without comparison greater than in the rocky Places: And in *Syracusa* the Difference was visible in 3 Places; that is, in the middle of the City, in the little Island, and in *Zaracati*, where the antient *Syracusa* stood; in all which Places, the Buildings being on a rocky Foundation, remain for the most part untouch'd, or only shaken, or at least not quite demolished: Whereas, on the contrary, in the rest of that Territory, which is not rocky, a very great Number of noble Structures and Towers lie like a horrid Desert, and Heap of vast Ruins.

The

The Effects it has had on human Bodies, altho' I do not believe they have all been immediately caused by the *Earthquake*, have yet been various; such as *Foolishness*, but not to any great degree; *Madness*, *Dulness*, *Sottishness*, and *Stolidity* every where; *Hypochondriack*, *Melancholick*, and *Cholerick* Distempers: Every day *Fevers* have been common, with many *Continual* and *Tertian*; *Malignant*, *Mortal*, and *Dangerous* ones, in a great Number, with *Deliria* and *Lethargies*. Where there has been any Infection caused by the *natural Malignity* of the *Air*, infinite *Mortality* has followed. The *Small-Pox* has made great Destruction among young Children; and in short, there has been no State nor Condition, which has not had its share in so universal a Calamity.

The Number of the Inhabitants before the Earthquake, and of those that Perished therein.

<i>The Names of the Cities.</i>	<i>Numb. of Inhab.</i>	<i>Numb. of those kill'd.</i>	<i>Names of the Cities.</i>	<i>Numb. of Inhab.</i>	<i>Numb. of those kill'd.</i>
<i>Agosta.</i>	6173	2300	<i>Mazzarino.</i>	7696	
<i>S. Agatha.</i>	1402	20	<i>Nicolosi.</i>	844	4
<i>Avola.</i>	6225	800	<i>Nixerni.</i>	1483	
<i>Buscema.</i>	2192	900	<i>Noto.</i>	12043	3000
<i>Bonaccorso.</i>	844	94	<i>Occhiella.</i>	2910	100
<i>Bontello.</i>	172	2	<i>S. Giovanni Lapunta.</i>	1082	15
<i>Butera.</i>	3492		<i>Jaci Reale.</i>	12895	739
<i>Buccheri.</i>	3295	300	<i>Jaci S. Antonio.</i>	6363	1335
<i>Caltagirone.</i>	12339	800	<i>Leontini.</i>	10063	1212
<i>Catanea.</i>	18914	18000	<i>Licodia.</i>	4898	741
<i>Comiso.</i>	5305	269	<i>Mineo.</i>		1355
<i>Castel di Jaci.</i>	331	32	<i>Palagonia.</i>	1862	29
<i>Carleontini.</i>	2751	77	<i>Pedara.</i>	1582	475
<i>Cassaro.</i>	1458	15	<i>Palazzolo.</i>	5571	700
<i>Chiaramonte.</i>	4830	303	<i>Ragusa.</i>	9946	5000
<i>Florida.</i>	1037	20	<i>Sortino.</i>	6316	2500
<i>Ferla.</i>	3610	800	<i>Syracusa.</i>	15399	4000
<i>Fenicia Moncada.</i>	1651	14	<i>Scicili.</i>	9382	2000
<i>Francofonte.</i>	2039	345	<i>Scordia.</i>	907	33
<i>Giarlatana.</i>	2981	541	<i>Spaccasurno.</i>	7987	2200
<i>Mascali.</i>	1300	15	<i>Trezza.</i>		200
<i>Massa Nunziata.</i>	394	55	<i>Trecastagni.</i>	3264	1000
<i>Militello Val di Noto.</i>	6438	600	<i>Terra Nova.</i>	5289	
<i>S. Michele.</i>	1838	1	<i>Tremisteri.</i>	996	90
<i>Melilli.</i>	5480	900	<i>Vittoria.</i>	3950	200
<i>Monterosso.</i>	234	232	<i>Terra Grande o Viu.</i>	1602	200
<i>Modica.</i>	18203	3400	<i>Vizzini. (Grande.</i>	10678	2000
				<i>Sum</i>	<i>254936</i>
					<i>59903</i>

An Earth-
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By P. Alva-
rez de Tole-
do. n. 209.
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1687-8. By
Dr. Hans
Sloan, n.
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XIX. The Inhabitants of Jamaica expect an *Earthquake* every Year, &c. Some of them are of opinion, that they follow their great Rains. One of them happened on Sunday the 19th of Feb. 1687, about 8 in the Morning. I found in a Chamber, one Story high, the Cabinets, and several other Moveables on the Floor, to reel, as if the Foundations of the House had been raised. I looked out at a Window, to see what was the matter, and found that the Pigeons, and other Birds, in an Aviary hard by, were on their Wings, in great astonishment. It came by Shocks; there were three of them with a little Pause between: It lasted about a Minute of time in all; and there was a small Noise accompanied it. A Pair of Stairs higher, it threw down most things off the Shelves, and had much more visible Effects than below. This was generally felt all over the Island, at the same time, or near it; some Houses therein being cracked, and very near ruined; others being uncovered of their Tiles: very few escaped some Injury; and the People in them were generally in a great Consternation, seeing them dance. The Ships, in the Harbour at Port-Royal, felt it; and one, who was Eastward of the Island, coming thither then from Europe, met with, as he said, at the same time, an Hurricane. One riding on Horse-back, was not sensible of it. A Gentleman being at that time abroad in his Plantation, told me, he saw the Ground rise like the Sea, in a Wave, as the *Earthquake* passed along, and that it went Northward; for that, some small time after he had felt it, he saw, by the Motion of the Tops of the Trees on Hills, some Miles distant, that it had then reach'd no farther than that Place. The Spaniards who inhabited this Island, and those neighbouring, built their Houses very low, and they consisted only of Ground-Rooms, their Walls being made of Posts, which were as much buried under Ground, as stood above, on purpose to avoid the Danger, which attended other manner of Building, from *Earthquakes*. And I have seen in the Mountains afar off, bare Spots, which the Inhabitants told me, were the Effects of *Earthquakes* throwing down part of the Hills, which continued bare and steep.

XX. 1. The terrible *Earthquake* which happened *June 7. 1692*, between 11 and 12 of the clock at Noon, shook down, and drowned 9 tenths of the Town of *Port-Royal*, in two *Minutes* time; and all by the *Wharf-side*, in less than one: very few escaped there. I lost all my People and Goods, my Wife and two Men, Mrs. B. and her Daughter; One White Maid escaped; who gave me an account, that her Mistress was in her Closet, two Pair of Stairs high, and she was sent into the Garret, where was Mrs. B. and her Daughter, when she felt the *Earthquake*, and bid her take up her Child, and run down; but turning about, met the Water at the top of the *Garret Stairs*: for the House sunk downright, and is now near 30 Foot under Water. My Son and I went that Morning to *Liguania*; the *Earthquake* took us in the Mid-way, between that and *Port-Royal*, where we were near being overwhelmed by a swift rolling Sea, 6 Foot above the Surface, without any Wind; but it pleased God to save us, being forced back to *Liguania*, where I found all Houses even with the Ground; not a Place to put one's Head in, but in *Negro-Houses*. The *Earth* continues (*June 20.*) to shake 5 or 6 times in 24 Hours, and often trembling. Great part of the Mountains fell down, and fall daily. I pray God divert those heavy Judgments which still threaten us.

2. We have had a very great *Mortality* since the *Great Earthquake*, (for we have little ones daily;) almost half the People that escaped at *Port-Royal*, are since dead of a *Malignant Fever*, from Change of Air, Want of dry Houses, warm Lodging, proper Medicines, and other Conveniences. September 23, 1692.

3. A great Part of *Port-Royal* is sunk; that where the Wharfs were, is now some Fathoms of Water: All the Street where the Church stood, is overflowed, that the Water stands so high as the upper Rooms of those Houses which are standing. The *Earth*, when it opened, swallowed up People, and they rose in other Streets; some in the middle of the Harbour, and yet were saved; though at the same time, I believe there was lost about 2000, Whites and Blacks. At the North, above 1000 Acres of Land sunk, and 13 People with it. All our Houses were thrown down all over the Island, that we were forced to live in Huts. The two great Mountains, at the entering into 16 *Mile-Walk*, fell, and met, and stopt the River, that it was dry from that Place to the *Ferry*, for a whole Day, and vast Quantities of Fish taken up, which was greatly to the Relief of the Distressed. At *Yellows*, a great Mountain split, and fell into the level Land, and covered several Settlements, and destroyed 19 White People. One of the Persons, whose Name was *Hopkins*, had his Plantation removed half a Mile from the Place where it formerly stood, and now good Provisions grow upon it. Of all Wells, from one Fathom to 6 or 7, the Water flew out of the top, with the great Motion of the *Earth*. Since, it has continued shaking, sometimes two or three times in a Day: so at Night, sometimes more, sometimes less; but God be praised, they are but small. Our People settled a Town at *Leguana-side*, and there are about 500 Graves already, and People are every day a dying still.

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By ib.
P. 85.

4. Between eleven and twelve a-clock, we felt the Tavern (where I then was) shake, and saw the Bricks begin to rise in the Floor, and at the same Instant heard one in the Street cry, *An Earthquake*. Immediately we ran out of the House, where we saw all People with lifted-up Hands, begging God's Assistance. We continued running up the Street, whilst on either side us, we saw the Houses, some swallowed up, others thrown on Heaps; the Sand in the Street rose like the Waves in the Sea, lifting up all Persons that stood upon it, and immediately dropping down into Pits, and at the same Instant, a Flood of Water breaking in, and rolling those poor Souls over and over; some catching hold of Beams and Rafters of Houses, others were found in the Sand that appeared, when the Water was drained away, with their Legs and Arms out; we beholding this dismal Sight: the small Piece of Ground, whereon 16 or 18 of us stood (God be praised) did not sink. As soon as the violent Shake was over, every Man was desirous to know if any Part of his Family were left alive. I endeavour'd to go towards my House upon the Ruins of the Houses, that were floating upon the Water, but could not: At length I got a *Canoe*, and row'd up the great Sea-side towards my House, where I saw several Men and Women floating upon the Wreck out to Sea; and as many of them as I could, I took into the Boat, and still rowed on, till I came where I thought my House had stood, but could hear of neither my Wife nor Family. Next Morning I went from one Ship to another, till at length it pleased God that I met with my Wife and two of my Negroes. She told me, when she felt the House shake, she ran out, and called all the House to do the same: She was no sooner out, but the Sand lifted up, and her *Negro Woman* grasping about her, they both dropt into the *Earth* together; and at the same instant, the Water coming in, rolled them over and over, till at length they caught hold of a Beam, where they hung, till a Boat came from a *Spanish Vessel*, and took them up.

The Houses from the *Jews-street* end to the *Breast-work*, were all shak'd down, save only 8 or 10, that remained from the Balcony upwards, above Water: And as soon as the violent *Earthquake* was over, the Watermen and Sailors did not stick to plunder those Houses; and in the time of their Plunder, one or two of them fell upon their Heads, by a second *Earthquake*, where they were lost.

As soon as the violent Shake was over, the Minister desired all People to join with him in Prayer; and amongst them, were several *Jews* that kneeled, and answered as they did; nay, I heard one say, they were heard to call upon *Jesus Christ*: A thing worth observation!

Several Ships and Sloops were overfet, and lost in the Harbour: Amongst the rest, the *Swan Frigate*, that lay by the Wharf to careen, by the violent Motion of the Sea, and sinking of the Wharf, was forced over the tops of many Houses; and passing by the House where my Lord *Puke* lived, part of it fell upon her, and beat in her Round House: she did not overfet, but helped some hundreds in saving their Lives.

As to the *Fire-Balls* which you heard were seen in the Air, it was a great Falshood; but a great and hideous Rumbling, was heard in the Mountains, infomuch

infomuch that it frightened many Negroes that had been run away some Months from their Masters, and made them come home.

The *Water* that issued from the *Salt-Pan-Hills*, forced its passage, in I believe 20 or 30 several Places, some more forcibly than others: For in 8 or 10 Places, it came with that violence, that had so many Sluices been drawn up at once, they could not have run with greater Force, and most of them 6 or 7 yards high from the Foot of the Hill: 3 or 4 of the least of them we observed were near 10 or 12 yards high in the Mountain. We tasted the *Water* in most of the places, and found it to be Brackish. It continued running that Afternoon, all Night and till next Morning about Sunrise, at which time the *Salt-Pans* were quite overflowed.

The Mountains betwixt *Spanish-Town* and 16 *Mile-Walk*, as the way lies along the River, if you remember, about the midway they are almost perpendicular, especially on the other side the River; those two Mountains in the *Violent Shake* of the *Earthquake* joined together, which stoppt the Passage of the River, and forced it to seek another, which was a great way in and out amongst the Woods and *Savana's*; for (as I have heard by several hands) it was 8 or 9 days before the Town had any relief from it: Infomuch that before it came, the People were in thoughts of removing into the Country, concluding it had been sunk as *Port-Royal* was. The Mountains along the River are so thrown on Heaps, that all People are forced to go by *Guanaboa* to the 16 *Mile-Walk*.

Mr. Bosby (who with his Wife had a miraculous Escape) told us, that that Afternoon, coming to his Plantations, he found the Ground opened in several places; and in one, two Cows were dropt in and smothered.

The Weather was much hotter after the *Earthquake* than before; and such an innumerable quantity of *Musquetoës*, that the like was never seen since the Inhabiting of the Island.

The Mountains at *Yellows* far'd no better than those of 16 *Mile-Walk*; a great part of one of them falling down, drove all the Trees before it, and at the foot of the Mountain, there was a Plantation that was wholly overthrown and buried in it.

The Mountains in *Leguonia* fell in several places, and in some very steep. Ib. p. 88.

The *Water* in the Streets in *Port-Royal* did not spout up as you have heard, but in the *Violent Shake* the Sand cracking and opening in several places where People stood, they sinking into it, the *Water* boiled out of the Sand, that covered many and saved others.

5. The Year 1692 began in *Jamaica* with very dry and hot Weather, which continued till May, when there was very *Blowing Weather* and much Rain till the end of the Month, from which time till the *Earthquake* happened, 'twas excessive hot, calm, and dry; and on Tuesday the 7th of June, about 40 Minutes past 11 in the Forenoon, it being then a very hot, clear, sun-shine Day, scarce a Cloud to be seen in the Sky, or a Breath of Air to be felt, happen'd that *Great Shake*, so fatal to this Place, and to the whole Island.

By _____
Communicated by Dr.
Love Moul-
ley. Ib. 89.

It began with a small trembling, so as to make People think there was an *Earthquake*, which Thoughts were immediately confirmed by a second *Shake* something stronger, accompanied all the while with a *Hollow Rumbling Noise*, almost like that of Thunder, which made them begin to run out of their Houses. But alas ! this was but short warning for them to provide for their safety ; for at the heels of this second, came the *Third Violent Shake*, which in less than a Minute's Time (it continuing near a Minute) shook the very *Foundation* of *Port-Royal* in such a sort that I believe 3 parts in 4 of the Houses and the Ground whereon they stood, and most part of those who inhabited them, all sunk at once quite under Water ; and on the place which was left, and is now standing, shook down and shatter'd the Houses in so violent a manner, that at our Landing it looked more like a Heap of Rubbish, than any thing else ; there being, I believe, scarce one House in ten left standing, and those so crack'd and shatter'd, that few of them were fit, or thought safe to live in, and stand now (*July 3. 1693*) empty. All those Streets which were next the *Water*, towards the *Harbour-side*, where there were excellent *Wharfs*, close to which, *Ships* of 700 Tun might lie and deliver their Loading, where were the best Store-Houses and Conveniences for Merchants, where were brave stately Buildings, where the Chief Men of the place lived, and which were in all respects the principal parts of *Port-Royal*, now lie in 4, 6, or 8 *Fathom Water*. That part which is now standing, is part of the end of that Neck of Land which runs into the Sea, and makes this *Harbour* (at the extremity of which, stands the *Fort*, not shook down, but much shatter'd by the *Earthquake*) and is now a perfect Island ; the whole Neck of Land, from the *Fort* of *Port-Royal* now standing to the *Pallisadoes*, or other end of *Port-Royal* towards the Land, (which is above a quarter of a Mile) being quite discontinued and lost in the *Earthquake* ; and is now also, with all the Houses, which stood very thick thereon, quite under Water : all which Part or Neck of Land (which is discontinued) as also all the other parts of this place which sunk, were, for what I can learn, nothing but perfect Sands, and by the People driving down Timber and Wharfing, &c. were by little and little gained in time out of the Sea, which now has at once recovered all again.

Capt. *Hals* and some others say, that when they came hither with *Venables*, the place whereon *Port-Royal* was since built, was like one of the Keys or little Islands that lie off this *Harbour*, (which by the way are all standing) but continued by a small Ridge of Sand, which then just appear'd above Water, with the other part of the Neck of Land, and I believe there is now as much Ground left standing as then.

And one who had been there some Years before, under one *Jackson*, (who took and plundred *St. Jago*, &c.) and returned with *Venables*, told Capt. *Hals* at his coming hither, that the Point or Place now standing, when he was here before, under the said *Jackson*, was wholly separated from the Land by the Sea, (as it is at this time) and pointing to the Ridge of Sand above-mention'd, said, That did not appear when I was here before. This is very probable, for already since the *Earthquake*, the Sandy Ground at the *Pallisadoes*, or other side,

side, hath gained from the *Sea* several Acres. On this *Sandy Neck* of Land did People build great heavy Brick-Houses, whose Weight on so *Sandy* a Foundation, may be supposed to contribute much to their downfall ; for the Ground gave way as far as the Houses stood only, and no further ; part of the *Fort* and the *Pallisades*, at the other end of the Houses, standing.

This part of *Port-Royal* which is now standing, is said to stand upon a Rock : but alas ! the strange *Rents* and *Tearings* of the *Mountains* here, sufficiently evince, that *Rocks* and *Sands* are equally able to withstand the Force of a *Violent Earthquake*. If this place be nothing but *Sand* (as some would have it, that are its no Well-Wishers) it seems strange that the Force of the *Earthquake* did not dissipate and dissolve the very Foundation of it, and that it did not fall to pieces and scatter under *Water*, as the rest of the Place did ; for the *Shake* was so violent, that it threw People down on their Knees, and sometimes on their Faces, as they ran about the Streets to provide for their Safety, and it was a very difficult matter to keep one's Legs. The Ground heaved and swell'd like a rolling swelling *Sea* ; ('tis a strange Comparison, but every body here using it, I venture to do so likewise) by which means several Houses now standing were shuffled and moved some yards from their Places. One whole Street (a great many Houses whereof are now also standing) is said to be twice as broad now, as before the *Earthquake*, and in many places the Ground would crack, and open and shut, quick and fast : Of which small Openings, I have heard Major *Kelley* and others say, they have seen 2 or 3 Hundred at one time, in some whereof many People were swallowed up ; some the *Earth* caught by the Middle, and squeezed to death, the Heads of others only appeared above Ground, some were swallowed quite down, and cast up again, with great quantities of *Water*, others went down and never were more seen. These were the smallest Openings : Others that were more large, swallowed up great Houses, and out of some Gapings would issue forth whole Rivers of *Water*, spouted up a great height into the Air, which seemed to threaten a Deluge to that part of *Port-Royal*, which the *Earth* seemed to favour, accompanied with ill Stench and offensive Smells : By means of which Openings, and the Vapours at that time belch'd forth from the *Earth* into the Air, the Sky which before was clear and blue, was in a Minute's time become dull and red-dish, (as I have heard it compared often) like a red-hot Oven. All these dreadful Circumstances occurring at once, accompanied all the while with prodigious loud Noises from the *Mountains*, occasioned by their Falling, &c. and also a hollow Noise under Ground, and People running from one place to another, with fear looking like so many Ghosts, and more resembling the Dead than the Living, made the whole so terrible, that People thought the Dissolution of the whole Frame of the World was at hand. Indeed 'tis enough to raise melancholy Thoughts in a Man now, to see the *Chimneys* and *Tops* of some Houses, and the *Masts* of *Ships* and *Sloops*, which partook of the same fate, appear above *Water* ; and when one first comes ashore, to see so many heaps of Ruins, many whereof by their largeness shew, that once there had stood a brave House ; to see so many Houses shatter'd, some half

half fallen down, the rest desolate and without Inhabitants; to see where Houses have been swallowed up, some appearing half above ground, and of others the Chimneys only: but above all to stand on the Sea-shore, and to look over that part of the Neck of Land, which for above a quarter of a Mile was swallowed up; there, where once brave Streets of stately Houses stood, appearing now nothing but Water, except here and there a Chimney, and some Parts and Pieces of Houses, serving only to mind us of their sad Misfortune.

And tho' *Port-Royal* was so great a Sufferer by the *Earthquake*, yet it left more Houses standing there, than in all the Island besides. It was so violent in other Places, that People could not keep their Legs, but were violently thrown down on the Ground, where they lay on their Faces with their Arms and Legs spread out, to prevent being tumbled and thrown about by the incredible Motion of the *Earth*, like that as is the general Comparison of a great Sea. It scarce left a Planter's House or Sugar-Work standing all over the Island: I think it left not a House standing at *Passage-Fort*, and but one in all *Liguania*, and none in *St. Jago*, except a few low Houses built by the wary *Spaniards*. And 'tis not to be doubted, but that had there been 500, or 5000, Towns in *Jamaica*, the *Earthquake* would have ruin'd every one. In several places in the Country the *Earth* gaped prodigiously: On the North side the Planters Houses, with the greatest part of their Plantations, (and the Planters Houses are not very near to one another) were swallowed Houses, People, Trees, all up in one Gape; instead of which appeared for some time after, a great Pool or Lake of Water, covering above 1000 Acres, which is since dryed up, and now is nothing but a loose Sand, or Gravel, without any the least Mark or Sign left whereby one may judge, that there ever had stood a Tree, House, or any thing else. In *Clarendon* Precinct, the *Earth* gaped and spouted up with a prodigious force great quantities of Water into the Air, above 12 Miles from the Sea; and all over the Island, there were abundance of Gapings or Openings of the *Earth*, many thousands; Marks of many whereof, which upon their closing they left behind them, any one cannot chuse but see, that goes into the Country; and I have seen several. But in the Mountains are said to be the most violent Shakes of all; and 'tis a generally received Opinion, that the nearer to the Mountains, the greater the Shake; and that the Cause thereof, whatever it is, lies there. Indeed they are strangely torn and rent, insomuch that they seem to be of quite different Shapes now, from what they were, especially the *Blue* and other *Highest Mountains*, which seem to be the greatest sufferers; which during the time of the first great Shake, and as long as the great Shakes continued, which was above two Months after the first Shake, (during which time the Shakes came very strong and thick, some times 2 or 3 in an hour) bellowed out prodigious loud Noises and Echoings.

Not far from *Yellows*, Part of a Mountain, after having made several Leaps or Moves, overwhelmed a whole Family, and a great part of a Plantation, lying a Mile off: And a large High Mountain, near *Portmorant*, near a Day's Journey over, is said to be quite swallowed up; and in the place where it stood, there is now a great Lake of 4 or 5 Leagues over. In

In the *Blue Mountain* and its high Neighbours, from whence came those dreadful Roarings, terrible and amazing to all that heard them, may be reasonably supposed to be many strange Alterations of the like nature : but those wild, desert Places, being very rarely or never visited by any body, not by Negro's themselves, we are yet ignorant of what happened there. But whereas they used to afford a fine green Prospect, now one half part of them at least, seemed to be wholly deprived of their Natural *Verdure*. There one may see, where the tops of great Mountains have fallen, sweeping down all the Trees, and every thing in their way, and making a Path quite from top to bottom ; and other places, which seem to be peeled, and bare, a Mile together : which vast peices of *Mountains*, with all the Trees thereon, falling together in a huddled and confused manner, stopped up most of the Rivers for about 24 Hours, which afterwards having found out new Passages, brought down into the Sea, and this Harbour, several hundred thousand Tun of Timber, as I have heard computed from the most knowing People there, which would sometimes float in the Sea in such prodigious quantities, that they looked like moving Islands. I have seen several of those large Trees on this Shore, all deprived of their Barks and Branches, and generally very much torn by the Rocky Passages, through which, by the force of a falling Stream and their own Weight, they might be supposed to be driven. One great Trunk of a Tree particularly, I have seen amongst the rest so squeezed as a Sugar-Cane after it had passed the Mill. Some are of opinion that the *Mountains* are *sunk* a little, and are not so high as they were ; others think the whole Island is *sunk* something by the *Earthquake*. *Port-Royal* is said to be *sunk* a Foot, and in many Places in *Liguania*, I have been told, are Wells which require not so long a Rope to draw Water out of them now, as before the *Earthquake*, by 2 or 3 Foot.

In this Harbour in *Port-Royal* at the time of the *Great Shake* (though the Seas were very calm) was suddenly raised such a strange *Emotion* in the Water, that immediately it swelled as in a Storm, great large Waves appearing on a sudden rolling with such a force, that they drove most Ships (if not all) in the Harbour from their Anchors, breaking their Cables in an Instant ; but this was soon over, and in a little time all was smooth again. One Capt. *Phips* told me, that he and another Gentleman happened at the time of the *Earthquake*, to be in *Liguania* by the Sea-side ; and that at the time of the *Great Shake*, the Sea retired from the Land in such sort, that for 2 or 3 hundred Yards the bottom of the Sea appeared dry, whereon they saw lie several Fish, some whereof the Gentleman who was with him ran and took up, and in a Minute or two's time the Sea returned again, and overflow'd great part of the Shore. At *Yallhouse* the Sea is said to retire above a Mile.

'Tis thought there were lost in all parts of the Island 2000 People, and had the *Shake* happened in the Night, very few would have escaped alive.

Since my arrival here I have felt several *Shakes*, the first and greatest whereof was on *Good Friday*, 1693. it lifted me compleatly off my Chair, and set me on my Legs, and was said to be a small *Shake* : but I did not then

hear the Noise (minding something else) which always immediately foreruns or rather accompanies it; but I have since felt several less *Shakes*, and heard the *Noise* often, which is very loud, and may be easily taken, by those not used to hear it, for a rustling Wind, or for a hollow rumbling Thunder; but hath some puffing Blasts peculiar to it self, and are most like those of a Match made of *Brimstone*, when lighted, but in a much greater degree, and such as a large Magazine of *Brimstone* may be supposed to make, when on fire. It is observable, that every small *Shake* is felt on Ship-board as sensibly as on Shore, the *Water* shaking as well as the Land.

It is likewise observed, that in windy Weather there never comes a *Shake*, but in very calm Weather it is always expected. This Observation hath held true in every *Shake*, that hath happened since the first great one.

'Tis observed, that after Rain, they are generally smarter than at other times; which may be from the shutting up of the Pores of the *Earth*, whereby the Force is more pent in, and hath not so free a Passage as to perspire and spend it self, &c.

Shakes often happen in the Country, not felt at *Port Royal*; and sometimes are felt by those that live in and at the foot of the *Mountains*, and by no body else.

'Tis observed, that since the *Earthquake*, the *Land-Breezes* often fail us, and instead thereof, the *Sea-Breezes* often blow all Night; a thing rarely known before, but since common.

In *Port-Royal*, and in many places all over the Island, much *Sulphureous* Combustible Matter hath been found, supposed to have been thrown out, upon the opening of the *Earth*, which upon the first touch of Fire, would flame and burn like a Candle.

St. Christophers, one of the *Caribee-Islands*, was heretofore much troubled with *Earthquakes*, which upon the *Eruption* of a great Mountain there of Combustible Matter, which still continues, wholly ceased, and have never been felt there since: wherefore many expect some such *Eruption* in some of the *Mountains* here, though we hope there is no necessity for it; the *Shakes* having been observed to lose their Force, and to become weaker and weaker ever since the first Fatal one; and 'tis now so long since we have heard any, except now and then one so weak as scarce to be felt, that we have great hopes they will now quite cease.

After the great *Shake*, those People that escaped, (as many as could) got on board the Ships in the Harbour, where many continued above 2 Months after; the *Shakes* all that time being so violent, and coming so thick, sometimes two or three in an Hour's time, accompanied with frightful Noises, both from under the *Earth*, and from the continual falling and breaking of the *Mountains*, that they dared not come ashore. Others went to the place call'd *Kingstown* (or by others *Killkown*) where, from the first clearing of the Ground, and from bad Accommodations, the Huts built with Boughs, and not sufficient to keep out Rain, which in a great and an unusual manner followed the *Earthquake*, lying wet, and wanting Medicines, and all Conveniences, &c. they died miserably in Heaps. Indeed there was a general

neral *Sickness*, (supposed to proceed from the hurtful Vapours belched from the many Openings of the *Earth*) all over the Island, so general that few escaped being Sick; and 'tis thought it swept away in many parts of the Island, 3000 Souls; the greatest part from *Kingstown* only, yet an unhealthy Place. Besides the great quantities of dead People floating from one side of the Harbour to the other, as the *Sea* and *Land-Breezes* blew them, sometimes 100 or 200 in a Heap; may be thought to add something to the *Unhealthfulness* of this Place. July 3. 1693.

6. Most of the *Ships* lost their Anchors and Cables which were towards the Wharfs or Town, which I suppose came from the Sands and Houses falling on them; and they after the *Earthquake*, rode in fewer Fathoms Water than before: and one may believe that some of the *Phænomena* may be accounted for from that.

XXI. The *Earthquake* which happen'd between the 4th and 5th of Jan. 1699. An Earthquake in 1699. at Batavia; sent to M. Nich. Witzén. By . . . n. 264. p. 595 hath had strange Effects about the *Tungarouse* and *Batavian Rivers*. The great *Batavian River* from above *Tangala Warna* being a Place from whence the said River receiveth the greatest part of its Water, is stopt up, or covered with *Earth* from the *Faln Hills*, till beyond the River *Tsyouspokitsyl*; so that the Place where the River had its Course formerly, was not to be seen. But far beyond that Hill, towards *Batavia*, the Water comes forth again from under the *Earth*, which is sunk down, but thick and muddy; passing over and thorough the Trees wherewith the River was formerly stopt up. The Trees lying in the River are of a special bigness, and so close packt together, that it is impossible to conceive how they came so.

From the Mountains situated near the beginning of the *Batavian River*, called by the *Javanians* *Songsy-tsaliwong*, seven Hills are sunk down, viz. 5 on this side, and 2 on the other. But the Mount from whence the River hath also its Source, above *Tangel Warna*, within the Mountains *Terbackti*, is not sunk down, nor hath received any damage.

The *Tangarang River*, call'd by the Natives *Songbi Sedani*, is also stopt up, and covered with *Earth*, from the Hill and Branch *Salack*, to the River *Autum*, and from thence to *Tangarang* being fill'd up with Trees; but not in such a quantity, nor so close together, as in the *Batavian River*. On this side the *Tangarang River*, 9 are sunk down by the *Earthquake*; and seven Branches, that had formerly their Issue in the River *Tangarang*, are also covered with the *Earth*; but three other Hills, lying also on this side of the same River, and call'd *Minjan*, *Dauw*, and *Halfichi*, had not sustained any damage, whereby the Branches *Autan*, and *Kaniki*, (the latter into the first Branch, and the first into the River *Tangarang*) have kept their Course. And the Hill *Oudjong-teboc*, being call'd also *Sedani*, from whence the *Tangarang River* had its Source, is not sunk down nor hurt. It is also observed, in the *Tangarang River*, at the Place where it is stopt up with Trees, that the descending Water being thick and muddy, went backward with a Motion not unlike the Waves of the Sea, when moved by a Tempest.

The High-Land between the *Batavian* and *Tangarang* Rivers, behind the old Court of the *Jacatra* Kings, called *Pakowang*, having been a great Wood, is changed since the *Earthquake*, into a great and open Field, wholly destitute of Trees, the Surface of the Ground being covered with a red Clay, such as the *Masons* use here ; which in some places was so hard, that it could endure treading and going upon it, and in other places Men did sink above a Foot into it. At the place of the Old Court called *Pakowang* situated between the *Batavian* and *Tangarang* Rivers, no other damage hath been seen, than that the Land thereabouts hath been rent and divided asunder with great Clefts more than a Foot wide. The River *Tfcome*, proceeding from a Pit or Well in the aforesaid Court of *Pakowang*, and running a great way under Ground, and then coming forth again, taking its Course towards *Anke*, had not received any harm : But kept its Course uninterrupted.

The *Tommagon Porbo Nata* in his going towards the Mountains, heard a Noise like unto Thunder ; and fearing that a sinking down of the Ground, or an Eruption of Water would follow, he stood still with those that were about him, and saw afterwards that the *Earth* from the top of the Mountains sunk down ; and hearing no further noise, he went on his Journey, having in going and coming back spent 19 Days by the Way, and felt 40 times an *Earthquake* : And since his return from the Mountains, he hath felt the like *Shakings* 208 times.

XXII. I have elsewhere shewn that the *Breath* of the *Pyrites* is *Sulphur ex*
The Cause of tota Substantia ; also that it naturally takes fire of it self : Again that the
Earthquakes
and Vulca-
no's ; By Dr
Mart. Lister.
n. 157. p. 512.
De Font. Med.
Angl. Material Cause of *Thunder* and *Lightning*, and of *Earthquakes*, is one and the same ; viz. the *Inflammable Breath* of the *Pyrites*. The difference is, that one is fired in the Air, the other under Ground : Of which last, these (I think) are sufficient Arguments ; A Thing burnt with *Lightning* smells of very *Brimstone* : again the Subtlety and Thinness of the Flame ; also the manner of its burning, which is often observed to be *Particulatim*, or in small Spots, Vapour like. And of *Earthquakes*, the *Sulphureous Stink* of Waters smelt before, and of the very Air it self after them : Of which innumerable Instances occur in the Relations of them.

They also agree in the Manner of the Noise, which is to be carried on, as in a Train fir'd, the one rolling and rattling through the Air, taking fire as the Vapours chance to drive, as the other fired under Ground in like manner moves with a desultory Noise, as it shall chance to be continued.

That the *Earth* is more or less hollow, is made probable, by what is found every where in the Mountains, viz. Natural Cavities or Chambers, which the Miners of the North call *Self-Opens*. These they meet with frequently, some vastly great, and others less, running away with small *Sinus's* : And I doubt not, but upon diligent inquiry, a great Catalogue of such might be had, discovered in the memory of Man. Besides, many there are, which are known to open to the Day, and to discover themselves without Digging, as *Pool's-Hole*, *Okey-Hole*, &c. Again, the great and small Streams, which do
 arise

arise from under the Mountains, do evidence the *Hollowness*, and *Sinousness* of them. Add to these, that many *Sinus's* are made in that instant, and are continued by the explosion and rending of the first Matter fired ; which may, and do very probably, close again, when the Force of that *Explosion* is over, but are sufficiently open to continue the *Earthquake*.

That these *Subterraneous Cavities* are at certain Times and in certain Seasons full of *Inflammable Vapours*, the *Damps* in our *Mines* sufficiently witness, which fired do every thing as in an *Earthquake*, save in a lesser degree.

Now, that the *Pyrites* alone (which is our present Task) of all the known Minerals, yields this *Inflammable Vapour*, I think highly probable, for these Reasons.

1. Because no Mineral or Ore whatsoever is *Sulphureous*, but as it is wholly, or in part, a *Pyrites* : I have carefully made the Experiment in very many of the Fossils of *England*, and I do find them all to contain Iron, wherever there is *Brimstone*.

2. Because there is but one Species of *Brimstone*, that I know of, at least with us in *England* : And since the *Pyrites* naturally and only yields it, it is but reasonable wherever *Brimstone* is found, though in the Air or under Ground in Vapour, to think that also proceeds from it. The *Sulphur-Vive* or *Natural Brimstone*, which is found in and about the *Burning Mountains*, is certainly the Effects of *Sublimation*, and those great Quantities of it said to be found about the Skirts of *Vulcano's*, is only an Argument of the long Duration, and Vehemency of those Fires. And though the *Sulphur-Vive* or *Rough Brimstone*, as they call it, had from *Hæcla* and *Italy* is Opaque, and agrees not with the Transparent and Amber-like *Sulphur Vive* of the Ancients ; yet it does not follow, that that also was not produc'd by *Sublimation*, no more, than that the *Stalactites*, or Water-wrought Stone, is not so made, for that some of it is Opaque and some Chryselline.

But possibly the *Pyrites* of the *Vulcano's* or *Burning Mountains*, may be more *Sulphureous* than ours. And indeed it is plain, that some of ours in *England* are very lean, and hold but little *Sulphur* ; others again very much. And this may be one Reason, why *England* is so little troubled with *Earthquakes*, and *Italy*, and almost round the *Mediterranean-Sea*, so very much. Another Reason is the Paucity of *Pyrites* in *England* ; where they are, indeed, some little in all Places, but mostly *sparsim* ; and if perchance in *Beds*, those are comparatively thin, to what probably they are in the *Burning Mountains*, as the vast Quantity of *Sulphur* thence *sublim'd* doth seem reasonably to imply. Also, if we compare our *Earthquakes*, and our *Thunder* and *Lightning* with theirs ; there it *lightens* almost daily, especially in Summer time, here seldom ; their *Thunder* and *Lightning* is of long Duration, here soon over ; there the *Earthquakes* are frequent, long, and terrible, with many *Paroxysms* in a Day, and that for many Days ; here very short, a few Minutes, and scarce perceptible. To this purpose, the *Subterraneous Cavities* in *England* are small, and few compar'd to the vast Vaults in those Parts of the World ; which is evident, from the sudden Disappearance of whole Mountains and Islands.

There

There are indeed other *Inflammable Minerals* besides the *Pyrites*: But by the Providence of God, not to be found in *England*, that I know of, and not in any Quantity in any Place of the World, that I can learn; which is well for Mankind, because they are very *Poisons* as the *Orpiments*: but they are specifically distinct from *Brimstone*, which no *Ore* yields but Iron; so the *Orpiments* are all *Gold Ore*. And by the bye, some Authors have assign'd this as a good Reason, against any Medicine that shall be made out of *Gold*, (as fond as we are of an *Aurum Potabile*) as having naturally a deleterious Quality.

It may be objected that no Body is *kindled by it self*: But it seems to me apparently otherwise; for that *Vegetables* will heat and take fire of themselves, as in the frequent Instance of wet Hay; and *Animals* are naturally on Fire, and Man doth then sufficiently demonstrate it, when in a Fever: And amongst *Minerals*, the *Pyrites*, both in Grofs and in Vapour, is actually of its own accord fir'd. Dr. Power has recorded at large, in his *Micrographia* a famous Instance of it; and the like not very rarely happens. And that *Damps* naturally fire of themselves, we have the general Testimony of *Miners* and the same *Author*.

Again the *Vulcano's*, all the World over, argue as much; for we, with great Probability, believe them to be Mountains made up in great part of *Pyrites*, by the Quantities of *Sulphur* thence *sublim'd*, and the Application of the *Loadstone* to the *ejected Cinder*. I go further:

That these *Vulcano's* were *Naturally Kindled* of themselves, at or near the Creation, is probable: Because there is but a certain known Number of them which have all continued burning beyond the Memoirs of any History; few or none of them that I know of, have ever totally decay'd or been extinct, (unless possibly by the *Submerfion* of the Whole, being absorb'd in the Sea. Though they, indeed, do burn more fiercely sometimes than at others, for other Reasons. So that it seems to me as natural, to have *actual Fire* in the *Terrestrial World* from the Creation, as to have Sea and Water.

Again if these *Vulcano's* did not *kindle of themselves*, what Cause can we imagine to have done it? If the Sun; we answer, *Haela* placed in so extrem cold a Climate was *kindled*, for ought I can see by the natural History of both, as soon as *Ætna* or *Fuegos*, or the most Southerly.

Not the Accidents happening from Man; for, if Man was (as we must believe) created Solitary and Topical, they were none of his Kindling, because they seem to be fired before the World could be all over peopled: Besides they are mostly the very Tops of vast high Mountains, and therefore the most unfit for the Habitation of Man.

If we say *Lightning*, and *Thunder*, or *Earthquakes*; we beg the Question: For the Cause of the one is the Cause of the other; and they are one and the same. It remains therefore (very probable) that they were *kindled of themselves*.

I for my part know no Subject in the whole Mineral Kingdom so general and lasting for the Fuel of these Mountains, as the *Pyrites*; which I have

have said alone does yield *Sulphur*, and naturally resolves it self into it, by a kind of Vegetation.

About the *Durable Burning* of the *Pyrites* these are Instances : *Scotch Coal* hath less of the *Pyrites* in it, being mostly made up of *Coal Bitumen*, and therefore it burns and consumes quickly, and leaves a white Cinder. *Sea-Coal*, or that Coal which comes from *Newcastle* by Sea to us, and for that reason so called, burns slowly ; and the *Sunderland Sea-Coal* so slowly, that it is said, by Proverb, to make three Fires ; this hath much *Pyrites* mixt with it, and burns to a heavy reddish Cinder, which is Iron, by the *Magnet*. But I have seen, and have a Specimen by me of a Coal from *Ireland*, (the Proprietor of the Pits is Sir *Christopher Wandsford*) which is said to be so lasting, that it will continue 24 Hours red-hot, and almost keep its Figure : This seems to be in great part *Pyrites* by the Weight and Colour.

XXIII. In the *Moores* from *Yeoil* towards *Bridgewater*, in the extreme Drought we have endured this Summer 1666, some Lengths of Pasture grew much sooner withered and parched than the other Pasture. And this parched part seemed to bear the length and shape (in gross) of Trees. They digg'd and found in the place Oaks indeed, as black as *Ebony*. And hence they have been instructed to find and take up many Hundreds of Oaks.

XXIV. In that *Fenny Tract*, called the *Me of Acholme*, lying part in *Lincolnshire*, and part in *Yorkshire*, has been abundance of Oak, Firr, and other Trees, of late frequently found in the *Moore* ; whereof some Oaks are 5 Yards in compass, and 16 Yards long ; others smaller and longer, with good quantities of *Acorns* near them, lying somewhat above 3 Foot in depth, and near their Roots, which do still stand as they grew, viz. in firm Earth below the *Moore*. The *Firrs* lie a Foot or 18 Inches deeper, more in Number than Oak, and many of them 30 Yards long, one of them being, not many Years since, taken up of 36 Yards long, besides the Top, lying also near the Root, which stood likewise as it grew, having been burnt and not cut down ; as the Oak had been also. Mr. *Dugdale* concludeth, that this *Moore* hath been so for divers hundreds of Years, and that the Cause thereof has been the muddiness of the *Tides*, which flowing up *Humber* into *Trent*, left in time so much Filth, as to obstruct the Currents of *Idle*, *Dun*, and other Rivers, which thence flowed back and overwhelmed that flat Country.

XXV. At *Toule* about 12 Miles below *Tork*, near the place where the *Dun* empties it self into the *Humber*, there are several Persons which are call'd *Tryers*, who, with a long piece of Iron, search in the soft and boggy Ground for *Subterraneous Trees* ; and by this way of Tryal, can in a great measure discover the Length and Thickness of these Trees, and get a Livelihood by it. Some are so large that they are used for Timber in building Houses, which is said to be more durable than Oak it self, others are split into *Laths* ; others are:

are cut into long *Chips*, and tied up in bundles, and sent to the Market Towns several Miles off, to light Tobacco. Those that I viewed, were all broken off from the Roots; I suppose by violence of Storm or Water, or both; and upon enquiry do find, that they are all after the same manner. These *Tryers* do affirm, that at three or four Yards deep they find *Stumps* of *Trees* broken off; some two, three or four Foot from the Ground, and to be exactly the same Wood with the *Subterraneous Trees*. The *Bate* or Texture of this Wood is the same with *Firr*, easily *splitting*: If burnt it sends out the same *Resinous Smell*, and it affords the same Coal. The Branches generally grow in Circles, as the Knots do testify: The Knots do easily part from the rest of the Wood, as is usual in *Firr-Wood*. The straightness and length of these *Trees*, are also a Presumption, that they must be such; if one consider that some of these are nigh a hundred Foot long, and at the bottom, not much above a Foot in Diameter. They affirm'd to me, that their tops lay all one way, (*viz.*) with the Current of the Water. There are also *Oaks* found there, though not in so great Quantity. The *Vitriolick* Parts of the *Earth*, in which they have lain, hath given them a black Tincture quite through, which (when wrought and polished fine) is not much inferior to *Ebony*. This Wood doth not emit the same Smell when burnt, with that call'd *Firr-Wood*; therefore I hope the Smell of that Wood will not be attributed to the *Bituminous* Parts of the *Earth* in which it hath lain. About 60 or 70 Years ago, several *Dutchmen* undertook to drain a large Marsh in that Place; and in cutting a Channel in the dry Ground betwixt the *Fen* and the River, at the first they threw up a *Rich* and *Firm Soil*, afterwards they met with a Stratum of *Sand*, under that a Stratum of *Boggy* Ground, in which they found of these *Subterraneous Trees*, and under that *Firm* Ground; and a Gentleman attested unto me, who had it from several Persons then living, that were Eye-Witnesses, that the *Firm* Ground in some Places lay *Ridge* and *Furrow*. There are several of these *Roots* of *Trees* to be seen in the Channel at Low-Water to this day, and yet there are neither *Firr* nor *Pine* growing naturally here, nor have been in the Memory of any Man; neither doth there remain any Tradition of the Growth of any such.

Fossile Wood
in Craven;
By Dr. M.
Lister, n.
224. p. 381.

XXVI. *Pimco* is one of the highest Mountains in *Craven* in *Yorkshire*, lying on the South-side of that Country, some two Miles above *Carleton*. On the South-side of the *Pike*, (as they call the very top of that Mountain) is a place where the *Water* stands; this is called a *Moss*, and is some Fathoms perhaps deep in black Mud. Here are dug up, if we will believe the Inhabitants, not only *Roots*, but whole *Trees* of *Firr*.

I saw there no small Marks of a Wood in former Ages; as the *Roots* or *Stumps* of *Trees* appearing above Ground; which upon due examination of the Grain and Bark, I found to be the *Roots* of *Birch*. These *Roots* split easily, and some dry; and when dried, they burn with a *lasting Flame*: and for this purpose they use them upon any sudden Occasion about their Houses. And altho' the *Flame* be great, yet it is without any *Resinous Smell*: However, it seems, that their having lain so long under Ground, has prepared the Juice for

for burning. There have been Oaks, as I have been told, dug up hereabouts also, but I saw none.

XXVII. On the South-side of *Mendip-Hills*, at a place call'd *Doulton*, Wood found in Stone, by Mr. J. Beaumont. Ph. Col. n. 2. p. 6. there are great Quarries of *Free-stone*, where the Workmen at five or six Fathom deep, sawing Stones of four or five Tun weight, have often found large Pieces of cleft and fair Oak in the midst of them.

XXVIII. *S. Septali*, in a Voyage he made a few Years since over some Mountains to *Genoa*, met with some Peasants, who digging on the sides of an Hill, had found and gathered very many *Cockle-Shells* of divers kinds, which he wonder'd at, and therefore went to the very Place; where he was satisfied of the Truth of the Relation, finding great store of different Shells, as the *Turbinets*, *Echini*, and some *Pearl-shells*, whereof one had a fair Pearl in it. Fossile Shells in Italy; By S. Manfredus Septalius. n. 27. p. 193.

XXIX. Upon the way of *Beziers* to *Narbonne*, in a Place pretty large, raised by Estimation above the Level of the Sea, (which is two Leagues distant from it) about 15 or 16 Fathoms, I saw Rocks which inclosed a good number of big *Oysters petrefied*: And upon the same Way above the Place, which is called *Nice*, at the highest place of the Descent, very cragged, where the Rock is cut to make a Passage, is seen a Bed two foot large of many *Cockle-shells petrefied*, heaped up, as ordinarily they are on the Sea-shore; which notes sufficiently, that the Sea formerly covered this Place. Fossile Shells in France; By M. de Martel. n. 58. p. 1183.

XXX. We will easily believe (what I have read in *Steno's Prodrumus*) that all along the Shores of the *Mediterranean Sea*, there may all manner of *Sea-shells* be found promiscuously included in *Rocks* or *Earth*, and at good distances too from the Sea. But for our *English* inland Quarries, I am apt to think, there is no such matter as *Petrefying* of *Shells* in the business: but that these *Cockle-like Stones* ever were, as they are at present, *Lapides sui generis*, and never any part of an *Animal*. It is most certain that our *English Quarry-shells* (to continue that abusive name) have no parts of a different Texture from the *Rock* or *Quarry* where they are taken, that is, that there is no such thing as *Shell* in these Resemblances of *Shells*, but that *Iron-stone Cockles* are all *Iron-stone*; *Lime* or *Marble*, all *Lime-stone* or *Marble*; *Sparre* or *christalline Shells*, all *Sparre*, &c. and that they were never any Part of an *Animal*. My Reason is, that *Quarries* of different *Stone* yield us quite different sorts of Species of *Shells*, not only one from another (as those *Cockle-stone* of the *Iron-stone Quarries* of *Allerton* in *Yorkshire*, differ from those found in the *Lead-Mines* of the neighbouring Mountains, and both these from that *Cockle-Quarry* of *Wansford-Bridge* in *Northamptonshire*, and all three from those to be found in the *Quarries* about *Gunthrop* and *Beavours Castle*, &c.) but, I dare boldly say, from any thing in Nature besides, that either the *Land* or *Salt*, or *fresh Water* doth yield us. 'Tis true that I have pick'd out of that one *Quarry* of *Wansford* very Resemblances of Fossile Shells in several Places of England; By Dr. M. Lister. n. 76. p. 2282.

Murices, Telina, Turbines, Cochlea, &c. and yet I am not convinced, when I particularly examin'd some of our *English Shores* for *Shells*, also the *fresh Waters* and the *Fields*, that I did ever meet with any one of those *Species* of *Shells* any where else but in their respective *Quarries*; whence I conclude them *Lapides sui Generis*, and that they were not cast in any *Animal Mold*, whose *Species* or *Race* is yet to be found in being at this day. I have two or three sorts of our *English Cockle-stones* of different *Quarries*, nearly resembling one the other, and all of them very like a common sort of *Sea-shell*; and yet there is enough in them specifically to distinguish them, and hinder them from being sampled by any thing of the *Spoils* of the *Sea* or *fresh Waters*, or the *Land-Snails*.

Fossile Shells
in Kent, By
Dr. Griff.
Hatley. n.
255. p. 463.

XXXI. At *Hunton*, 5 Miles from *Maidstone* in *Kent*, and about a quarter of a Mile from the River *Medway*, after the Copping of a piece of Ground was taken off, (which was of a Clay about 3 Foot deep) we came to a very good *Blue Marle*, which continued such 3 Feet and $\frac{1}{2}$ deep more; and then there appeared a hard Floor or Pavement composed of *Shells*, or *Shell-like Stones*, crowded closely together; the *Interstices* whereof were filled up with the same *Marle*. This Layer (which runs as the *Veins* of *Flints* do in chalky *Earth*) was about an Inch deep, and several Yards over, and we could walk on it as on a *Bench*; under this Layer we came to *Marle* again. I cannot, upon inquiry, find that in the memory of any *Man* thereabouts, any *Floods* from the River have reached so far as this place.

The *Stones* (for I take them to be *Lapides sui Generis*) are of that sort which is call'd *Conchites*, and resemble *Sea-Fish* of the *Testaceous* kind; most of them are *Turbinated*, or wreathed, the rest are of the *Bivalvular* sort, but I have not found any of them with *Valves* closed together, but single.

The bigness of the *Turbinated*, is from a *Vetch* to a *Hazle-Nut*, they are filled with a *Terra Lapidosa*, like the *Marle*, and are of that colour till you have washed and rubbed them, and then they appear of the colour of *Bezoar*, and of the same Politure. After they have been boiled in *Water*, they are whitish, and leave a *Chalkiness* upon your *Fingers*, which when it is rubbed off, gives you a view of very fine black *Stria*, thick set on the outside. These *Wreathed Stones* are all perfectly formed, they differ not in Figure one from another, but that some have their sides a little depressed; upon a few of them there adhered a little proportion of a glittering *Mineral* like *Iron*. In *Vinegar*, they made a strong and a boiling *Effervescence*.

The *Bivalvular* are most of them no bigger than a *Kidney Bean*, some lesser, a few as broad as the largest sort of *Beans*, but the *Valve* much thinner than any of that kind, which had been the *Exuvia* of an *Animal*; the gibbous Part of the *Valve* is smooth, and of the same colour with that of the *Turbinated*. In a few there are some oblong *Lineations* bent circularly to the *Commisfure* of the *Valve*: I have a piece of such an one by me, consisting of several *Lamellæ*; which hath this further observable in it, that the gibbous Part is of a most beautiful black shining Colour, and the inner Part of a shining *Pearl-colour'd Substance*.

Of this *Bivalvular* sort, many of them seem to be *in fieri*, not as to their Shape, but as to their Hardness and Thickness, there being in some only the *prima Stamina*, and in others the several Steps and Progresses toward a perfect *Figuration*; which seems to me an unanswerable Argument, for their never having been the *Spoils* of *Animals*. Some of these appeared in the Inner-side white, and it came off upon the Fingers like Chalk, and seemed as if a Depression had been first made in the Bed of the Shape of a *Valve*, and then the Convex side rubbed with Chalk or painted white.

Those Pieces of this odd *Concretion*, which I keep by me (now the *Marle*, which is in the Interstices, is grown hard) appear much like that coarse sort of *Marble-stone*, which is dug about *Pluckley* in the *Wild* of *Kent*. Which *Marble* seems to be a *Coagmentation* of such *Shell-like Stones*, the *Marle* betwixt them having acquired firm Solidity and Hardness. With this *Stone* they make their *Causeys* in that part of the Countrey; and they are apt to be worn into little Cavities, or Holes, where they have lain long exposed to the Air; the Rains, in length of time, washing away the Portions of *Marle* (which is less hard than the rest) from the Orifices and Interstices of those *Shell-like Stones*. I am much confirmed in this Opinion by a piece of *Marble*, inlaid, as it were, with such *Stones*, which was dug out of a *Marle-Pit*, at a little distance from, and on the same level with that at *Hunton*.

The imperfect as well as the complete Formation of some of the *Bivalvular* kind (the *Valves* being only found single, and both sorts in a Ground never heretofore disturbed) are no light Arguments for their being *Stones*. Perhaps the Salts of Plants or Animal Bodies, washed down with Rains, and lodged under Ground, may be there disposed into such like Figures, as well as above it.

XXXII. Near *Reading* in *Berkshire*, for many succeeding Generations, a continued Body of *Oyster-shells* has been found through the whole Circumference of 5 or 6 Acres of Ground. The Foundation of these Shells is a hard rocky Chalk, and above this Chalk the *Oyster-shells* lie in a Bed of green Sand upon a Level, as high as can possibly be judged; this *Stratum* of green Sand *Oyster-shells* is (as I measured) high two Foot deep. Now immediately above this Layer, or *Stratum* of green Sand and *Shells*, is a Bed of a bluish sort of Clay, very hard, brittle and rugged, they call it a pinny Clay, and this is of no use. This Bed or Layer of Clay, I found to be high a Yard deep; and immediately above it is a *Stratum* of *Fuller's Earth*, which is high two Foot and a half deep; this *Earth* is often made use of by our Clothiers: And above this *Earth* is a Bed or Layer, of a clear, fine white Sand, without the least mixture of any *Earth*, *Clay*, &c. which is high 7 Foot deep: Then immediately above this is a stiff red Clay, (which is the uppermost *Stratum*) of which we make our Tiles. The Depth of this cannot be conveniently taken, it being so high a Hill, on the top of which hath been and is dug up a little common *Earth* about 2 Foot deep.

I have, with a Mattock, dug out several whole *Oysters* with both their *Valves*, or *Shells* lying together, as *Oysters* before opened: in their Cavity there

there is got in some of the forementioned green Sand. These Shells are so very brittle, that in digging for them, one of the *Valves* will frequently drop from its Fellow ; but 'tis plainly to be seen that they were united together, by placing the Shell that drops off to its *Fellow Valve*, which exactly corresponds : But I dug out several that were *Entire* ; nay, some *double Oysters* with all their *Valves* united.

Fossile Shells
and Fishes in
Lincoln-
shire; By Mr.
Abr. de la
Pryme. n.
266. p. 678.

XXXIII. In a *Quarry* at the East-end of *Broughton* in *Lincolnshire*, they get a Clayey Substance or *Earth*, that lies under the Stone in which are innumerable Fragments of the Shells of Shell-Fish of various sorts, of *Pectinites*, *Echini*, *Conchites*, and others, with some Bits and Pieces of *Cornel* ; and there are sometimes found whole Shell-Fish, with their natural Shells on, in their natural Colours, most miserably crack'd, bruised and broken, and some totally squeez'd flat by the great Weight of the *Earth* that yet lies, and that was cast upon them in the *Noachian Deluge*.

There is another *Quarry* in the Field on the South side of the *Town*, of a hard blue Stone, which was most certainly a pure fine blue Clay, in some *Antediluvian Lake*, in the Stones of most of which are innumerable *Petrefied* Shell-Fish of various sorts, but so united to the Stone, that it is very difficult to get them whole out ; and I have always found that they lie in the Superficies of the *Quarry*, within a Foot of the Top thereof, and few or none deeper therein. In many places of the Surface of the *Quarry*, (which looks rugged and drifted, as Snow does after a Storm, and by which one may find what Quarter the Storm or Wind was then in) there are many Shell-Fish half in the Stone, half out. That part which is within the *Quarry* is entire and whole, but a hard Stone ; and that part which is without, which the *Petresick Effluvia* did not touch, is consumed and gone, all but a little of the Edges which are plain Shell, and have all the *Radii* and *Stria* on them, that the common Shells of those sorts of Fishes have.

All these Fishes have their Shells on, some of which Shells are exceeding thin, to what other some are. Sometimes the Shells of some of them are in their *Petresfaction* so thoroughly united unto and incorporated with the Stone, that they are scarce visible. Others in the same *Quarry* have a thick white Shell on them *Petresfied*, but not incorporated and turned into the Substance of the Bed in which they lie. As you get that Fish out, all the Shell sticks so fast to the Rock, that most commonly it is left behind, but sometimes the Shell cleaves in two, one half of the Shell on both sides of the Fish sticks thereto, and the other half to both sides of the Bed, but others come out by lying in the Air in Frosty Nights, with the whole natural Shell on them, and the *Radii* or *Stria* very exact. Other Fish there are here, that have a black smooth Shell on them, with several *Stria*, but no *Radii*, very like, if not the same with the *Concha Nigra Rondel*.

I have also seen in this *Quarry* some Shell-Fish half open and fill'd with the Matter of the Bed in which they lie, and *Petresfy'd* with it. Others being in heaps together, I have found some of them broken, others bruised, and the Edges of one Fish thrust into the sides of another, some with the one

Shell.

Shell thrust half way over the other, &c. and so *Petrefied* in the Bed together. Others in the same Bed have been so close, that the Matter of the Bed could not insinuate it self into them. These that are thus found, are some of them totally empty, others are filled with *Christaline Fluors*, others I have seen half full of the said bluish Clay of the Bed, and half full of the said *Christallizations*, which have stuck therein, from nothing but *Subterraneous Heats* and *Effluvioms*.

Amongst these Fish in this Quarry, I have seen several great *Horse-Muscles*, such as breed in *Fresh-Water Rivers* and *Ponds*, which are exactly like the *Concha Longa Rondel*, but are more thick, full, and pubble, than ours commonly are at this day ; which Greatness and Largeness proceed from nothing but the Fertility and Fatness of the Bed on which they bred ; and at this Day in an old Pond beyond *Broughton-Hall*, there are some of the largest of this sort of *Shell-Fish* that ever I saw, as if this Soil agreed better to the breeding of this sort of Fish than any else ; just as the *Cornu Ammonis*, *Nautili*, and others breed best upon *Alum Soils* : And that is the reason that they are found so much at *Whitby*, *Rochel*, *Lunenburg*, *Rome*, and other Places, where are famous *Alum-Mines*. And if any one would find any of those sorts of Fishes (which some learned Men have ridiculously thought to be Species totally lost) they ought in all probability to seek for them upon *Alum Soils* in the Sea, and there they would undoubtedly find them.

Others have an *Ouzey Soil*, a sort of a confused Mixture of several Soils together, as part of the Country about *Frodingham*, *Bramber*, *Asbbe*, *Botsworth*, &c. seems to be ; in the Fields and Stones of which Towns, is one particular sort of Fish, which I know not what *Genus* or *Species* to compare to, bending somewhat like a *Ram's Horn*, and exactly creased like one on the out-side with an *Opusculum* thereon, which the Fish opened and shut as it had occasion. The Bed whereon the said *Shell-Fish* bred in the *Antediluvian Sea*, is not over a Foot thick (to the best of my Memory) in all which, but for the most part in the Superficies thereof, are millions of the said Fish sticking half within the Stone, half without ; which *Shell-Fish* having a most durable Shell, that part which sticks out of the Stone, is not consumed, as in the *Shell-Fish* of *Broughton*, but remains whole and entire. And yet I have seen and found whole lumps of them, that by some huge Weight cast or fallen upon them, in the *Noachian Deluge*, have been miserably broken and shattered in pieces, and so *Petrefied* in the Bed as they lay.

In the Parish of *Broughton* aforesaid, in the loose *Earth* above the aforesaid blue Quarry, and elsewhere, I have found in a whitish Stone, the *Echini Galeati Puncticulati Lluydii*, the *Turbinites Major. Lluydii. Tab. 7. N. 341.* the *Cochlites Lævis Vulgatiior. Lluydii. T. 7. N. 322* ; in blue Stone, the *Concha altera Longa Rondeletii*, exactly agreeing to the Picture and Bigness thereof in *Gesner de Piscibus*, p. 231: only the *Neb* is much longer : I have found also multitudes of *Belemnites*, great and little, perforated and flat at the Root, by which they grew in the *Antediluvian Sea*, unto some of which I have found little *Shell-Fish* sticking.

Theræ

There have been many Contests and Disputes amongst the Learned concerning these Appearances ; but my Notion of them is, that the *Antediluvian World* had an external Sea as well as Land, and Mountains, Hills, Rivers, and fruitful Fields and Plants ; that it was about the Bigness that our Earth is at present of, and that when God had a mind, for the Wickedness of the Inhabitants that dwelt thereon, to destroy the same by Water, he broke the Foundations and subterraneous Caverns and Pillars thereof with most dreadful *Earthquakes*, and caused the same to be for the most part, if not wholly, *absorbed* and swallowed up, and covered by the Seas that we now have ; and that this Earth of ours rise then out of the Bottom of the *Antediluvian Sea* in its room : just as many Islands are swallowed up, and others thrust up in their stead.

From this happy System of the *Deluge*, which is the most concordant to the Scriptures of all others, all those things are easily solved that were hard and difficult before. It is no longer a Wonder that Shells, and Shell-Fish, and the Bones of other Fishes and Four-footed Creatures, and Fruits, &c. are found (as they commonly are) in Beds and *Quarries*, in Hills and Mountains, and in the Bowels of the Earth ; for here they bred in the *Antediluvian Sea*, thither they were elevated with the Hills and Mountains in the time of the *Deluge*, there they fell into, were absorbed and buried in Chasms, and Holes, and Clefts, that would necessarily happen in the thrusting up of the Earth, and are found in the Soil that was flung and carried with wonderful Violence and Confusion from one Place to another, by the working of the Waters, and the Ferment and Hurry that they were put into.

And as all Countries were thus raised out of the Bottom of the *Antediluvian Sea* and *Lakes*, so that part of the Country, about *Broughton* aforesaid, appears manifestly, in the *Antediluvian World*, to have been the Bottom of some *Fresh-water Lake*, because that those are *Fresh-water Shell-Fish* which are found there ; and the Bed, upon which they bred, was a fine blue Clay, which is the Colour of the Stone to this day : Which Bed being *elevated* and lifted up (and dashed over with other Earth in the Workings of the Waters, and the great Hurry and Confusion that then happened) the said Bed, by the power of the *Subterraneous elevating Heats, Steams, and Effluvioms*, was turned by degrees into Stone, with all the Fishes therein.

I have before told you, that some of the Shell-Fish, in the same Bed, are not only full of the Matter of the Bed, but of *Fluors*, tho' such are not very common. Some might wonder, seeing that the Shells are closed, that the Matter of the Bed could insinuate itself into them ; but that is nothing but what is common in like Cases : for I have frequently seen, in the Bottoms of Ponds and Rivers, where such Shell-Fish in plenty are, that when the Fish is dead and consumed, and the Shell in the Mud, with the Edges as close as if the Fish was alive, that nevertheless the Mud or Clay will, by degrees, insinuate and fill the same. And now if the Bottom of any one of the said Rivers or Ponds was raised by *Earthquakes*, and turned into Stone by *Petresick Effluvioms*, they would exactly be found as these are.

That

That many *Shell-Fish* suffered such wonderful great Violence and Force in the said great Flood, insomuch as to be crush'd, and bruis'd, and squeez'd flat, as some of these manifestly are; is likewise nothing strange or wonderful, if we do but consider the great pieces of rising Rocks, and Hills, and Mountains, that must needs roll down, and fall, in such a general hurry and confusion as that must needs have been in the Quarry, at the East end of this Town of *Broughton*: where Fragments of innumerable Shells are found, and some *Shell-Fish* squeez'd flat, all which are natural, and not petrefy'd. There was in the *Deluge* flung upon the same a huge Bed of a mix'd confused Substance, now turn'd into a whitish soft canker'd Stone, and upon that were cast vast quantities of *Earth*, all which weigh'd and pressed the tender Shells so much, that they squeez'd some flat, and broke others to pieces, as we find them to be at this day.

I have a hard Stone, part of the aforesaid blue Quarry, with little Bits of *Wood-Coals* therein, and whole *Leaves* of *Vaccinia*, or *Whortle Berries*, such as grow upon *Heaths* very exact: And Mr. *Lluyd* and others have given us several large Accounts of whole *Leaves* and *Plants* found in Stones and Rocks, and deep in the Bowels of the *Earth*, some folded, some plain, some imperfect; all which is very easily solvable, having in that general confusion and hurry been seized upon and embody'd in Lumps of Clay and other Matters, and others caught and intercepted in Rolling Beds of *Earth*, as they tumbled down from rising Hills and Mountains, and so lodg'd deep in Chasms of the Ground and petrefy'd, and so preserv'd unto this day.

XXXIV. I have had out of the Isle of *Sheppey* in the River of *Thames*, Glossopetra, By Dr. Lister. n. 110. p. 223. very *Sharks Teeth* dug up there; which could not be said to be petrefied. They were somewhat gilded with a *Vitriolick* Tarnish at our first receiving them; but they were white, and in a short time came to their natural Colour.

In the *Stone Quarries* in *Hinderskelf Park* near *Malton* in *Yorkshire*, I took out of the Rock my self a fair *Glossopetra* with three points of a black Liver-Colour, and smooth; its Edges are not *Serrate*; its Basis is (like the *True Teeth*) of a rugged substance; it is carved round the Basis, with Imbossed Work: It hath certain eminent Ridges, or Lines like Rays, drawn from the Basis to each Point.

XXXV. Dr *Tancred Robinson* received lately from *Maryland* a considerable number of *Fossile Bones* and *Shells* of several sorts. Some of them had received little alteration in the *Earth*, others more, and some were so changed as to be stony: But all of them retained their ancient Shape. One of these *Fossiles* I compared with the Tongue of a Fish I had observ'd The Fossile Tongue of a Palatinaca Marina; By Dr. Hans Sloane. n. 232. p. 674. in *Jamaica*, and with another of the same Tongues in pieces, which I saw in Mr. *Charleston's* most useful and admirable Collection of *natural Curiosities*, and found a perfect Agreement. Another of these *Fossiles* I suppose

suppose is the upper *Mandible* or *Palate* of this Fish, which is opposite to, or answers this *Tongue*: The Agreement of this in all parts with the *Tongue*, making it very likely to belong, if not to this same, yet to this kind of Fish.

A Part of one of the Joints of this *Tongue* was dug up in *England*, and given to Mr. *Charleton*, by Mr. *Lluyd* of *Oxford*, by the Name of *Siliquastrum Subnigrum Pectinatum Maximum*.

Fig. 87, 88. Dr. *Robinson* thinks the *Fossile Palate* or *Mandible*, Fig. 87 and 88. may be of the same kind with that taken notice of by *Lachmund*, in his Book de *Lapidibus*, p. 17. where 'tis call'd *Pentacrinous*.

Fig. 75. Fig. 75. Is the whole *Tongue* of a *Flat-Fish* a-kin to a *Thornback*, which I call *Pastinaca Marina*, *Lævis*, *Livida*, *Albis Maculis notata*. It is made up of many Bones (about 19 in this) which are each of them crooked, their two sides making an obtuse Angle, such as the sides of the *Under-Mandible* of a *Man* does: the uppermost sides of these several Bones have *Furrows* and *Pieces* standing together after the manner of the *Teeth* of a short small-toothed Comb, the extant Ends of which answer the like Parts in the Bones of the upper *Jaw* of this Fish, between which and this *Tongue* the Food of this Fish is to be cut, torn, or ground to pieces.

Fig. 76. Fig. 76. Is the underside of the same divided into several Pieces also, but having no *Furrows* or *Teeth*, as those of the upper side have.

Fig. 77, 78, 79, 80. Fig. 77, 78, 79, 80. Shew the Joints or Pieces of the same *Tongue*, separated in several Positions of their upper and under sides, to shew the perfect Agreement between the Pieces of the *Tongue* of the Fish taken lately from it, and those taken out of the *Earth*, which are figur'd in the like Positions. Fig. 81, 82, 83, 84, 85, 86.

Fig. 81, 82, 83, 84, 85, 86. Fig. 87, 88. Are the upper and under sides of what, I suppose, is the Fig. 87, 88. *Upper-Mandible* or *Palate* of this Fish, which is opposite to, and answers this *Tongue*.

Mr. *Willoughby* and Mr. *Ray* call this Fish *Nari-Nari*; and I am apt to believe the Anonymous *Portuguese*, whose Description of *Brazil* is published in *Purchas*, Lib. 7. Cap. 1. p. 1313. means this, when he says there were Rays, having in their Mouth two Bones breaking Wilks with them.

Horns of A- XXXVI. I had lately an Opportunity of particularly examining a com-
merican Deer pleat Head, with both its Horns entirely perfect, not long since dug up in
found under Ireland, and given to my Brother *Will. Molineux*, as a natural Curiosity, by
Ground in Ireland; by Mr. *Henry Ostorn*, that lives at a Place call'd *Dardistown*, in the County of
Dr. Tho. *Meath*, about 2 Miles from *Drogheda*. This is the *Third Head* which hath
Molineux n. been found by casual trenching in his *Orchard*; they were all dug up within
227. p. 489. the compass of an Acre of Land, and lay about 4 or 5 Foot under ground, in
a sort of boggy Soil. The first Pitch was of *Earth*, the next 2 or 3 of *Turf*, and
then followed a sort of *white Marle*, whereby they were found.

I took the *Dimensions* of this *Head* carefully, as follows, from the extreme Tip of the right *Horn*, to the extreme Tip of the left *AB*, was 10 Foot 10 Inches; from the Tip of the right *Horn*, to the Root where it was fastened to the *Head CD*, 5 Foot 2 Inches; from the Tip of the highest Branch (measuring one of the *Horns* transverse, or directly across the *Palm*) to the Tip of the lowest Branch *GF*, 3 Foot 7¹/₂ Inches. The Length of one of the *Palms*, within the Branches *GH*, 2 Foot 6 Inches; the Breadth of the same *Palm*, still within the Branches, *IK*, 1 Foot 10¹/₂ Inches; the Branches that shot forth round the Edge of each *Palm*, were 9 in Number, besides the *Brow-Antlers*, of which the right *Antler DL*, was 1 Foot 2 Inches in Length, the other was much shorter; the *Beam* of each *Horn M*, at some distance from the *Head*, was about 8 Inches in Circumference; at the Root where it was fastened to the *Head*, about 11 Inches in Circumference; the Length of the *Head* from the back of the Skull to the tip of the Nose, or rather the Extremity of the upper Jaw-bone *NO*, 2 Foot; the Breadth of the Skull where largest *PQ*, was a Foot. There were 2 *Holes* near the Roots of the *Horns* that look'd like *Eyes*, but were indeed large open Passages, near an Inch in Diameter in the *Forehead-bone*, to give way to great Blood-Vessels, that here issue forth from the *Head*, and pass between the Surface of the *Horn*, and the smooth hairy Skin that covers them whilst they are growing, (which is commonly called the *Velvet*) to supply the *Horns* with sufficient Nourishment, while they are soft, and till they arrive at their full Magnitude, so as to become perfectly hard and solid.

These Vessels, by reason of their Largeness and great Turgency of the Humour in them, whilst the *Horn* is sprouting and pliant, make deep and conspicuous Furrows all along the outside of it where they pass, which may plainly be seen after the *Horn* is bare and come to its full Growth, at which time all these Veins and Arteries, with the outward *Velvet* Skin, drying by the Course of Nature, shrivel up and separate from the *Horn*, and the Beast affects tearing them off in great Stripes against the Boughs of Trees, exposing his *Horns* naked when they are thoroughly hardened, without any covering at all.

Such then were the vast *Dimensions*, according to which the lofty Fabrick of the *Head* and *Horns* of this stately Creature was built: And yet it is not to be questioned but these spacious *Horns* as large as they were, like others of the *Deer-kind*, were naturally cast every Year, and grew again to their full size in about the space of 4 Months. For all Species of *Deer* yet known certainly drop their *Horns* Yearly, which I conceive to proceed from the same cause, that *Trees* annually cast their ripe Fruit, or let fall their withering Leaves in *Autumn*; that is, because the nourishing Juice, say it is Sap or Blood, is stopped and flows no longer, either on the account it is now deficient, being all spent, or that the cavous Passages which convey it, dry up and cool, so as the Part having no longer any Communication with, must of necessity by degrees sever from the *Whole*; but with this difference, that *Horns* by reason of their hard, material, and strong Composition, stick fast to the *Head* by their Root 7 or 8 Months after all their Nourishment perfectly retires,

whereas *Leaves* and *Fruit*, consisting of a much more tender Substance, and a finer Texture of Parts, drop sooner from their native Beds where they grew, when once the Supply of usual Nourishment is stopt. This Analogy that *Nature* observes in casting the *Horns* of Beasts, and dropping the *Fruit* of Trees, will appear much more evident to any one that will observe the end of a Stalk, from which a ripe *Orange*, or any large *Fruit*, has been lately sever'd, and the But-end of a cast Horn, where it is fastned to the *Os-Frontis*; for by comparing them together, he shall find so great a Congruity in the Shape of both, that 'twill be apparent, *Nature* works according to the same *Mechanism* in one as in the other.

Such another *Head*, with both the *Horns* entire, was found some Years since by one Mr. *Van Delure*, in the County of *Clare*, buried 10 Foot under Ground in a sort of *Marle*, and was presented by him to the late D. of *Ormond*. In the Year 1691, Major *Folliot* told me, that digging for *Marle* near Town. *Ballymackward* near *Ballyshannon* in the County of *Fermanagh*, he found buried 10 Foot under plain solid Ground, a pair of these sort of *Horns*. In the Year 1684, there were two of these *Heads* dug up near *Turvy*, within 8 Miles of *Dublin*.

Not long since a *Head* of this kind, with its *Horns*, was found near *Portumny*, seated on the River *Shannon*, in the County of *Galloway*. Such a *Forehead* with 2 extraordinary *Beams* of these kind of *Horns*, may be now seen fastened against one side of the *Common Hall* of his Grace *Michael* Lord Archbishop of *Ardmagh*'s House here in *Dublin*; they are both imperfect and want their *Palms*, yet by the vast thickness and length of the *Beams*, I judge, when entire, they much exceed the size of those I have given the dimensions of above. The *Primate* told me, they were found somewhere in the Province of *Ulster*.

To these I might add many more Instances of the like; as those found by the late Lord *Mountjoy*, near his House at *Newton Stewart*, and those kept at *Stockallen* in the County of *Meath*: for to my knowledge, within less than 20 Years, above 20, I might safely say, 30 pair of these sort of *Horns* have been dug up in several places of this County, all found by accident; and we may well suppose vast numbers still remain undiscovered: but these may suffice plainly to shew, this Creature was formerly common with us in *Ireland*, and an indigenous *Animal*, not peculiar to any Territory or Province, but universally met with in all parts of the Kingdom. We may also reasonably gather, that they were a *Gregarious Animal*, as the *Naturalists* call them, or such a sort of Creature as affect naturally keeping together in *Herd*s; as we see the *Fallow Deer* with us, and as 'tis reported of the *Elches* in *Sweden*, and the *Rain Deer* in the Northern Countries of *Europe*; for otherwise we cannot easily fancy it should happen, that three of their *Heads* should be all found within the narrow compass of one Acre of Ground.

That these and several others, and indeed I think I may say all that I have been particularly inform'd of, though dug up in far distant places of *Ireland*, should be constantly found buried in a sort of *Marle*, seems to me

me to intimate, as if *Marle* was only a Soil that had been formerly the outward Surface of the Earth, but in process of Time, being covered by degrees with many Layers of adventitious Earth, has by laying under Ground a certain Number of Ages acquired a peculiar Texture, Consistence, Richness or Maturity, that gives it the Name of *Marle*. For of necessity we must allow the Place where these *Heads* are now found, was certainly once the external Superfice of the Ground, otherwise it is hardly possible to suppose how they should come there.

And that they should be so deep buried as we at present find them, appears to have happen'd by their accidentally falling where it was soft low Ground; so that the Horns by their own considerable Gravity might easily make a Bed where they settled in the yielding Earth, and in a very long course of Time, the higher Lands being by degrees dissolved by repeated Rains, and wash'd and brought down by Floods, covered those Places that were situated lower, with many Layers of Earth: For all high Grounds and Hills, unless they consist of a Rock, by this means naturally lose a little every Year of their height, and sometimes sensibly become lower even in one Age; of which we may see several satisfactory Instances related by Dr. Plot in his *Natural History of Staffordshire*, Chap. 3. Page 113. As for all such Heads that might chance to fall on high or hard Grounds, where they could not possibly be covered or defended, these must of necessity rot, perish, and be destroy'd by the Weather.

By what means this kind of Animal, formerly so common and numerous in this Country, should now become utterly lost and extinct, deserves our Consideration.

Some have been apt to imagine this, like all other Animals, might have been destroyed from off the Face of this Country, by the Deluge in the Time of *Noah*: But if we consider what a fragil, slight and porous Substance these and the Horns of all *Deer* are, we cannot well suppose they could by any means be preserved entire and uncorrupt from that *Flood*, now above 4000 Years since; and I have by me some of the Teeth, and one of the lower Jaw-bones of this Creature so perfect, solid, ponderous and fresh, that no one that sees them can possibly suspect they could have been in Nature so many Ages past: And therefore it seems more likely to me, this kind of Animal might become extinct here, from a certain ill Constitution of Air in some of the past Seasons long since the Flood, which might occasion an *Epidemick Distemper*, if we may so call it, or *Pestilential Murrain*, peculiarly to affect this sort of Creature, so as to destroy at once great numbers of 'em, if not quite ruin the Species. For this Island may very well be thought neither a Country nor Climate so truly proper and natural to this Animal as to be perfectly agreeable to its Temper, since for ought I can yet learn, it neither is, nor ever has been an Inhabitant of any of the adjacent Kingdoms round about us. And besides the three Heads abovementioned, found so close to one another in the County of *Meath*, and the two near

Turvy, seems not a little to countenance this Opinion, as if these Animals died together in Numbers, as they had lived together in *Herd*s. To this purpose, *Scheffer* in his *Laponia* speaking of the *Rain Deer*, an Animal that agrees in Kind with ours, tho' it be a quite different sort of *Deer*, says, that whole *Herd*s of them are often destroyed by a raging Distemper like a Plague, common among them; and that sometimes they all die, so that the *Laplander* is forced to supply himself with new.

'Tis probable however, that some of them might have escaped this common Calamity: But these being few in Number, I imagine as the Country became peopled, and thickly inhabited, they were soon destroy'd and kill'd like other *Venison*, as well for the sake of Food as Mastery and Diversion. And certainly these savage Ages of the World would not have spared the rest of the *Deer Kind*, *Stags* and *Hinds*, *Bucks* and *Does*, which we still have, but that these, being of a much smaller Size, could shelter and conceal themselves easier under the Covert of Woods and Mountains, so as to escape utter Destruction.

And here I cannot but observe, that the *Red Deer* in these our Days, is much more rare with us in *Ireland*, than it has been formerly, even in the Memory of Man: And tho' I take it to be a Creature, naturally more peculiar to this Country than to *England*, yet unless there be some Care taken to preserve it, I believe in process of time, this Kind may be lost also, like the other sort we are now speaking of.

It remains that we enquire what *Species* of *Animals* it was, to which these stately *Horns* formerly belong'd. I know it is an Opinion generally receiv'd, that they belonged to the *Alche*, *Elche*, or *Elende*, and therefore are vulgarly call'd *Elche's Horns*: But I have seen a pair of genuine *Elche's Horns* brought out of *Swedeland*, and they differed extremely both in *Figure* and *Size*, from these we have now described. They were abundantly smaller, and quite of another *Shape* and *Make*, not *palmed*, or broad at the end farthest from the *Head*, as ours; but on the contrary, broader towards the *Head*, and growing still narrower towards the *Tips End*, the smaller *Branches* not issuing forth from both *Edges* of the *Horns* as in ours, but growing along the upper Edge only, whilst the other *Verge* of the *Horn* was wholly plain without any *Bran-*
ches at all. The faithful *Gesner* speaking of the *Size* of them says, *Cornua singula Libras circiter duodecim appendunt, Longitudine fere duorum Pedum*: Whereas the *Horns* we find here in *Ireland* are near thrice that Length, and above double that Weight, tho' dried and much lighter from their being so long kept. Moreover the *Elche*, as described by *Apollonius Menabenus*, who had seen many of them, is no larger than a middling Horse. And Mr. *Duncombe* told me, when he was Envoy in *Sweden*, he had seen there above 100 *Elches* together in a *Herd*, and none of them above 5 Foot high. And if so, we cannot imagine a Creature of that small Size, could possibly support so large and heavy a Head, with so wide and spreading a pair of *Horns* as these we are speaking of; considering that exact *Symmetry*, and due Proportion of Parts, Nature observes in the Formation of all the larger and perfecter sort of Animals.

De Quadrup.
c. 1.

But the Description of that lofty horned Beast in the *West-Indies* call'd a *Moose*, much better agrees with our *Irish* Animal than that of the *Elche* does. This Animal I find described by Mr. *John Josselyn*, among his *New England Rarities*, in these Words: *The Moose Deer, common in these Parts, is a very goodly Creature, some of them 12 Foot high, (in height, says another Author more particularly, from the Toe of the Fore-Foot to the Pitch of the Shoulders, 12 Foot; in its full Growth much bigger than an Ox) with exceeding fair Horns with broad Palms, some of them two Fathoms or twelve Foot from the Tip of one Horn to that of the other. This is 14 Inches wider than ours was. Another thus describes the manner of the Indians Hunting this Creature: They commonly hunt the Moose, which is a kind of Deer, in the Winter, and run him down sometimes in half, otherwhile a whole Day, when the Ground is covered with Snow, which usually lies here four Foot deep; the Beast, very heavy, sinks every step as he runs, breaking down Trees as big as a Man's Thigh with his Horns; at length they get up with it, and darting their Lances, wound it so, that the Creature walks heavily on, till tired and spent with loss of Blood, it sinks and falls like a ruined Building, making the Earth shake under it. So that we have not the least reason to question but these vastly large Irish Deer and the American Moose, were certainly one and the same sort of Animal, being all of the Deer Kind, carrying the same sort of palmed Horns, which are of the same Size and Largeness as well as Figure; and the Bulk of their Bodies corresponding exactly in Proportion to the wide spreading of their Horns. So that we may securely assert, that Mooses formerly were as frequent in this Country, as they have them still in the Northern Parts of the West-Indies, New England, Virginia, Maryland, and Canada or New France.*

And lest we may think this Animal peculiar to the Continent, and not to be found in Islands, a remarkable Passage in *John de Laet's Description* of the *West-Indies* clearly shews the contrary: *There are found, says he, great Numbers of these Animals in an Island near the Continent, call'd by the English Mount Mansell. This may give us reasonable Grounds to believe, that as this Island of Mount Mansell must of necessity have had some Communication with the Main-Land of America, to have been thus plentifully stock'd with this sort of Beasts; so Ireland, for the same Reason, must in the many past Ages, long before the late Discovery of that New World, have had some sort of Interchange with it likewise, (though 'tis not easy, I acknowledge, for us at present, to explain how) for otherwise I do not see, how we can conceive this Country should be supply'd with this Creature, that for ought I can yet hear, is not to be found in all our Neighbourhood round about us; nay perhaps in any other Part of Europe, Asia, or Africa: And then 'tis certain, as Ireland is the last or most Western Part of the Old World, so 'tis nearest of any Country to the most Eastern Parts of the New; Canada, New England, Virginia, &c. the great Tract of Land, and the only one I yet know, remarkable for Plenty of the Moose Deer.*

XXXVII. *Tonna inter Thuringia Dynastias haud postrema, Erfurto propinqua, Comitibus olim Glichenfibus paruit, iisque extinctis varios sortita Dominos*

An Elephant
found under
Ground near
Erfurt in
Germany;
By Will. Ern.
Tentzelius.
n. 234 p. 757.

minos Ducatui tandem Saxo-Gothano annexa est, ex quo serenissimus Princeps, Fredericus, cujus Filium Cognominem feliciter hodie Regnantem suspicimus, A. 1677. jure Emptionis Hæreditario sibi suisque eam comparavit. Binos habet Pagos seu Villas ejusdem Nominis, quorum alter appellatur *Burg-Tonna*, quasi *Castrum Tonnæ*, alter *Grafen-Tonna*, quasi *Comitis-Tonnæ* diceres. Uter illorum antiquior sit, definire nequeo: Id saltem constat Annalibus vetustissimum Pagum esse, qui *Donnaba* audit in Diplomate *Ottonis Magni*, A. Chr. 973 dato, meaque Opinione ad *Burg Tonnæ* spectat. Proxime Pago huic adjacet Mons sive Collis *Arenosus*, arenam in fundo præbens purissimam albissimamque, in variorum Artificum usum longe lateque transportari solitam: Quam effodientes Mense Decembri An. 1695. Ossa quædam maxima reperiunt, ad Pedes posteriores spectantia, unum 19 Librarum pondere; deinde Globum sive *Caput Rotundum* Acetabulo insertum, Capite Viri majus, 9 Librarum; hinc Majus Os Femori simile 32 Librarum. Solito post Novi Anni initium Frigore amplius inquirentes, offendunt Spinam Dorfi cum Costis adhærentibus, profundiusque in Arena abditos *Globos* longe majores binos, una cum ossibus eo pertinentibus, Pedum nempe Anteriorum; tum Os Humeri, 4 Pedes longum, duasque Spithamas latum cum dimidio: Mox Vertebra Colli cum Vertice acuminato; denique *Caput* prægrande cum 4 Dentibus Molaribus, quorum singuli 12 Libras pendebant, & Duobus maximis Dentibus, sive Cornubus, $2\frac{1}{2}$ Spithamæ Crassitie, & 8 Pedum Longitudine ex Capite prodeuntibus. Ut Caput melius conspiceretur, Collis 12 fere Cubitorum, sive 24 Pedum Altitudine perforatus est; quo facto ipse serenissimus Princeps 10 Kal. Feb. accessit, meque inter Comites esse clementissime jussit, ubi omnes quidem in magno Hominum Concurfu Caput illum cum Dentibus prægrandibus admirabundi contemplati sumus, maxime autem indoluimus, & Caput & Dentes, exceptis Maxillaribus, quos integros fere accepimus, & reliqua Ossa, adeo fragilia, consumpta Carie, situque corrupta jacuisse, ut nullum eorum ex omni parte incontaminatum erui potuerit, sed in plurimas Particulas disjecta fuerint.

Cum primum Fama emaneret, vulgarem simul Opinionem de *Ossibus Gigantis* ea circumferebat, qua tamen nec mihi, nec aliis prudentioribus arrisit, & viso *Capite* statim evanuit. Postea vero duæ Opiniones emerferunt, quarum altera, pro *Elephantis Sceletis*, Temporis diuturnitate maximam partem putrefacto; altera pro *Unicornu Fossili*, ut vulgo vocant, seu Minerali jocantis Naturæ Fœtu, habuit. Prior sententia mihi comprimis placet. Ex Collatione enim *Sceleti nostri* cum Anatomia *Elephantis* quam Dublini in *Hibernia*, A. 1681. dedit A. *Moulinus* clarissime liquet omnia huic nostro convenire, quæ ad vera *Elephantis Ossa* requiruntur. Ante omnia notandum est, quod *Moulinus* refert in *Cranio Elephantis* extare magnum *Cellularum* Numerum, plerumque Triangularem, Membranulis obductarum, in quibus multa sint *Vasa sanguinea* curiose disposita, istasque *Cellulas* ex tenuibus Bracteis Osseis factas esse. Enimvero *Cranium Tonnense* non tantum intus *Concavum* & instar Tumuli Formicarum perforatum fuisse referunt Fosfores, sed è Fragmentis idem liquet manifestissime, quæ *Cellulas* istas, modo oblique, modo directe *Cranium* trans-euntes,

euntes, nobis ob Oculos ponunt, ex tenuibus Bracteis constantes, & maximam partem Triangulares; Membranulas autem, *Vasis sanguineis* exsiccatis, firmissime agglutinatas deprehendimus, Colore flavo subrubicundo tinctas, scalpro forte tentatas in frustula dissilire, simulque Colorem istum auferre, ut Albedo *Cranii* emineat. Præterea quem *Moulinus* in *Cranio* observat Meatum *Medulla spinalis*, & singularem Cavitatem pro *Cerebro* capiendo in nostris etiam Fragmentis apparet: & quam ille metitur Distantiam *Cranii* ab uno extremo ad alterum $20\frac{1}{4}$ *Digitorum*, in nostro dicitur fuisse $3\frac{1}{2}$ *Pedum*, qui cum 42 *Digitos* faciunt, tum Conjecturam nobis præbent, *Elephantem Tonnensem Hibernico* fuisse ad minimum duplo majorem; quod ex sequentibus clarius patebit. De externa *Cranii Elephantini* forma alius *Anglus*, *Joannes Raius*, in *Synopsi Animalium Quadrupedum* observat, *Posticam* ejus partem in duos prægrandes *Simus* seu *Lobos* ita dividi, ut *Clunes Humanos* referre videatur; neque, ut in aliis multis *Quadrupedibus*, *Cerebello* excipiendo Cavitatem, seu Alveum productum extrorsum conspicuum habere, sed potius *Cranii Humani* Figuram imitari. Obtestor omnes, qui *Caput* in *Arena* jacens viderunt, annon hæc Definitio ipsi apertissime conveniat. Cæterum *Longissimi Dentes* illi sive *Cornua*, præter Crassitiem & Longitudinem indicatam, simul referebant. Nativum *Lævorem*, Colorem *Subflavum* nigricantibus *Maculis* subinde conspersum, *Curvaturam*, & *Strias* nullis aliorum *Animalium Dentibus Cornubusque* communes: Imo quod maxime notari meretur, superest adhuc *Cuspis* dextri *Dentis*, apertissimo *Limationis* signo conspicua, de qua *Plinius Arbore exacuere limareque* Lib. 18. *Cornua Elephantos* memorat. Neque præterierim, inter alios, qui ad visendum *Tonnense* spectaculum undique adfluebant; venisse etiam Mercatorem, qui multos Annos in *India* consumpserat, & secundum *Regulas Indorum*, quas sibi probe cognitatas dicebat, ex *Dentibus* sive *Cornubus* judicabat *Elephantem nostrum* plusquam 200 Annos vixisse. Quam in rem *Aldrovandus* allegat *Aloyssi Cadamustsi* Testimonium, vidisse se aliquando *Elephantem* occisum perquam Mediocre, cujus *Dentium* amplitudo *Palmos* (i. e. *Spithamas*) *Ternos* excedebat, eminebat ad duos *Palmos*, verum *Palmus* contactus *Carne Maxilla* immergebatur, ut totus occultaretur, ut sunt aliorum *Radices Dentium*; & quoniam eorum *Senecta Dentibus* cognoscitur, aiebant *Argumento Dentium* fere despiciabilis, ipsum haud quaquam *Annosum* fore, si conferretur aliis Procerioribus, quorum *Dentes* tantæ sunt *Magnitudinis*, ut vicem *Postium* suppleant, & pro *Palis* sepes muniant, Teste *Plinio*, & ut *Nigrita* referebant, nonnullis eo Amplitudinis crescunt *Dentes*, ut 12 *Palmorum* *Mensuram* excedant. Ultima Verba cum primis ad Propositum nostrum faciunt: *Palmum* enim *Cadamustus* intelligit *Majorem*, quem *Spithamam* alioquin dicimus; 12 igitur *Palmi* 8 faciunt *Pedes*, quæ Longitudo est *Dentium Tonnensum*. Non multum hinc abit *Dens Harduino*, Commentatori *Plinii* novissimo, *Dieppæ visus* septemum fere *Pedum*, *Centum* & amplius *Librarum* pondere: Præterea *Gillius* adferit, eos sæpe ad Longitudinem 10 *Pedum* augescere. Nec est quod *Pondus Centum* & amplius *Librarum* in *Dentibus Tonnenfibus* quenquam deterreat: Reperiuntur enim, quorum singuli pendent 140. *Libras*, qualem apud *Batarvos* vidit *Amicus*; vel 150, sive 200. *Romani-Ponderis Duodecim unciarum*, quales *Erasmus Francisci* memorat, vel 160, qualem in *Musæo Septaliano* describit *Terzagus*; quin *Ver-*
tomannus.

tomannus in Sumatra duos vidit, qui appensi Libras 336 pendebant. Nobis interea sufficere potest certum Ministri cujusdam Ducalis Testimonium qui aliquot Annos in Sumatra aliisque India Regionibus vixit, testaturque Dentes sibi visos fuisse Longitudine sex vel octo Pedum, Crassitie duarum & dimidia Spithamarum pondere centum & 25 Librarum. Veterem Disputationem, Cornua Dentesve sint appellandi, non definio; neque tamen negaverim: placere mihi Aldrovandi Bochartique de media illorum Natura Sententiam, quam Origo confirmat. Pausania pridem notata, quia Temporibus superne descendere, & ita foras tendere, non auritus, sed oculatus Testis scripsit, viso in Campanio Elephantis Cranio; eundemque situm Tonneses præ se ferebant, quibus non obflare potest Moulini Raiique Observatio, è Maxilla superiore eos derivantium, internamque eorum Constitutionem ita nobis depingentium, quod intus concavi sint, & quadam velut Medulla, verum compactiore, quæque Glandularum aliquam mixturam habere videbatur, repleti: addit Raius, ex Observatione Lewenhoeckii, Eos ex conjunctis iisque admodum exilibus Tubulis constare, ex intima parte seu Cavitate Dentis Originem trahentibus, & ad Circumferentiam ejusdem terminatis. Cæterum hos Tubulos manifestissime in qualibet Dentium Tonnesium parte conspiciamus, una cum Corticibus quasi illis in rotundum extensis, quibus Elephantorum Dentes singulis vel Annis, vel majoribus Vitæ interstitiis, distingui videmus; verum, ne quid dissimulem, neuter nostrorum latiori pollet Cavitate, quam quousque Capiti seu Tempori, vel potius Maxilla Superiori, inserti fuerunt; nec majorem Cardanus Aldrovandusque in omnibus agnoscunt, & quanquam ea a Mouliano, Raioque latius extenditur, non alios tamen, quam Juniorum Elephantum Dentes producere poterunt, Seniores autem non alio modo comparatos puto, quam Tonneses, ejusque differentia Causam in eo sitam esse, quod in Senioribus Tubuli isti Corticesque non tantum ad extra augeantur, sed etiam ad infra magis magisque constipentur & coalescant, ac simul Medulla compactior Glandulisque mixta sensim conglobetur & condensetur.

Progredior ad Dentes Molares, quorum quatuor stupendæ Magnitudinis ponderisque in Capite Tonnesi reperti fuerunt, iisque exactissime convenit Raii Definitio, his Verbis concepta: Os Beviæ quatuor in utraque Maxilla Dentium Molarium Massis instructum. Siquidem plurimi Dentes in Os solidum & durum ita infixi sunt, ut cum eo & inter se unum & continuum Corpus efficiant. Dentes hi Lineas Parallelas undulatas octo vel novem in Superficie Massæ efficiunt, suntque reliquo osse Candidiores. Massæ integræ Dentium singularium modo per Gomphosin Maxillis inseruntur: Anterior tamen in Superiore Maxilla extremitate altera in Maxillam infigitur, deinde Palato Oris Parallelos Antrosum producta, in acutum tandem Mucronem definit, qui in Sinu ad id factò in extremitate Maxillæ excipitur.

Incisoribus omnino caret. Equidem his caret etiam noster Elephas Tonnesis, singulæ vero Massarum Molarium constant Osse duro & vitri instar candenti, nucleoque; tum in superficie duodecim Lineas Parallelas undulatas, sive Strias Molares habent, reliquo Osse candidiores, in quolibet latere sedecim Striæ expressæ sunt, totidemque Cavitatibus per Gomphosin Maxillis inserti fuerunt; quas ubi Scalpro perfoderis, repletas invenies dura quadam ac rubicunda

teria, Medullæ Vasorum Nervorumque Petrefactæ simillima : Præterea parte illa qua ex Maxilla prominuerunt, luculenter apparet Lavitas duorum fere Digitorum, qualem in Hibernicis notavit etiam *Moulinus*. Nec est, quod deterri nos patiamur octonario Hibernicorum Numero, quanquam eundem in alio *Elephanto Peirescium*, Brachio suo in Os Belluæ ingesto, deprehendisse *Gassendus* narrat ; pro Quaternario enim stant non tantum ex Antiquis *Aristoteles* & *Plinius*, sed & ex Recentioribus *Walter Schultze*, qui diu in India versatus est, ipseque, ut videtur, *Raius* qui alioqui non in utraque sed singulis Maxillis quatuor Dentes dicere debuisset. Causam differentię quærere licet vel in Naturæ Varietate, quæ ut in aliis Animalibus, Homineque ipso, ita etiam in *Elephantis* Numerum Dentium non semper eundem producat ; vel in Etatis differentia, ita ut Dentibus Posterioribus in juventute excisis Anteriores, copioso adfluente Nutrimeto, spatium expleant. Certe *Quatuor Tonneses* in posteriore sui parte manifestissimas habent Extremitates Processusque incurvatos, ex quibus liquet, in Maxillæ extremitate illos constitisse ; eosdem pars Anterior ostendit, & qui superiori Maxillæ inserti fuerunt, non solum Longiores sunt Inferioribus, secundum *Moulini* Observationem, sed in Acutum quoque Mucronem desinunt a *Raio* observatum : Imo omne fere Maxillæ expleant spatium, quod *Octo* isti apud *Moulinum* ; metitur enim Longitudinem Anterioris Dentis in Maxilla inferiori sex Digitis cum Dimidio Posterioris tribus ; Totius vero Maxillæ $21 \frac{1}{2}$ Digitis, uti Superioris Maxilla 18 Fossiles *Tonneses* Discrimen hoc non satis observantes eandem utriusque Maxillæ Longitudinem dixerunt, Trium nempe Pedum, sive Triginta sex Digitorum. Dentes autem Maxillares sibi invicem insistentes repperunt, Longitudinem singulis Unius & Dimidiæ Spithamæ adsignantes, quam tamen accuratiori examine diversam reperi ; Superiorum quidem propter Acutum Mucronem Quindecim fere Digitorum, Inferiorum vero Quatuordecim. Accipimus autem Distantiam Maxillarum, quam iidem dederunt Fossiles, Trium & Dimidii Pedis, sive 42 Digitorum : eaque cum distantia 21 Digitorum, quam inter Ossa Lygomata sive Jugalia statuit *Moulinus* collata, denuo deprehendimus Magnitudinem *Elephantis Hibernici Tonnesem* bis æquasse ; idem confirmat distantia Cranii ad uno Extremo ad alterum, in *Hibernico* 20 $\frac{1}{2}$ Digitorum, in *Tonnesi* Trium & Dimidii Pedum.

Repertæ fuerunt etiam Vertebrae Colli, seu Cervicis, (juxta Dimensiones a Fossilibus indicatas) Crassitiæ quatuor Spithamarum in Circumferentiâ, duarum Altitudine ; quarum adhuc Tres optime sibi respondentes supersunt, earumque præcipua monstrat Verticem Acuminatum. Repertum est Os Humeri cum Acetabulo & Capitibus sive Globis duobus maximis adhuc residuis, Pedumque Anteriorum Ossibus, Ulnæ, Radii, Carpi & Metatarsi, quorum nonnulla tantæ fuerunt Cavitationis, ut manus tota inferi potuerit ; singula autem referta non Arenis, sed minutissimis Medullæ Petrefactæ particulis, quæ Ori indita non Stridorem Dentium causantur, Arenæ instar, sed in Lingua liquefcunt, Gustuque Terreo Transmutationem istam produnt. Repertæ sunt Vertebrae Dorsi cum Costis adstantibus, sed nihil ex iis integrum evasit : Duo tantum Fragmenta Costarum exigua vidi, alterum Crassitiæ undecim, alterum plus quam 7 Digitorum. Repertum porro est Os Coxendicis $2 \frac{1}{2}$ Pedis.

Longitudine, cum Acetabulo & inserto Femoris Capite; *Moulinus* Longitudinem illius non exprimit, sed Ossis Innominati, 25 Digitorum: at Os Coxendicis tertia tantum pars est Ossis Innominati; reliquas duas, Os Ilium & Pubis, Fossores dimetiri neglexerunt. Reperta sunt Ossa Crurum Pedumque Posteriorum, Tibiæ, Fibulæ, Tarfi, & Metatarfi: e quibus adhuc supererat pars Tibiæ, Principio & Fine carens, Crassa tamen superiori parte 22 Digitos, quibus sursum versus sex alios facile accrevisse *Moulinus* docet; inferiori parte habet Crassitiem 17 Digitorum, indeque rursus duplex emergit Crassities, ac Longitudo Hibernici, cuius Tibiam dicit *Moulinus* Longam 19 Digitos; Rotundam, ubi Crassissima, plusquam 14, & ubi Tenuissima, 7½ Digitos. Hic notanda est major Pedum Anteriorum præ Posterioribus Validitas & Crassities Elephantis propria, & ab Alberto Aldrovandoque explicata. Neque enim tantæ Capacitatis est Tibia, ut Manum intrudi patiatur, quod in quibusdam Ossibus, Ulnæ sine dubio, licuisse Fossores aliique memorant. Denique supersunt bina ex Tarfi Ossibus sibi invicem contigua, ne quisquam dubitet, illa etiam adfuisse. Omnia isthæc Ossa porosa & rimosa sunt, ut in reliquis Animalibus, alteriusque plantæ Formæ, ac Dentes, tam Maxillares, quam Exerti.

Situm quoque totius Animalis attendere juvat. Cornua sive Dentes Maximos versus Ortum ac Septentrionem protendebat; Pes Anterior sinister Lateri Capitis adjacebat extensus; dexter sub Corpore deorsum inclinatus; sinister Posterior in Acetabulo incurvatus, Dexter denique initio statim reperi- tus, & hinc inde distractus fuit. Quæ omnia situm minime naturalem vel ordinarium, sed extraordinarium plane violentumque produnt. Tandem Fossores referunt, Ossa quidem illa jacuisse debita series, sed ubi sunt Inarticulationes, partim Palmi, partim Semipalmi [Palmum Minorem quatuor digitorum intelligo] spatio distincta fuisse. Quorum Rationi Pinguedine, Cartilaginibus ac Ligamentis, Carne denique ac Intestinis sita est, quibus Putrefactis vacuum Locum Arena occupavit, Artusque Pondere suo magis magisque disjuncti.

Nunc ad aliam Disquisitionem venio. An illa sint Unicornium Fossile sive Minerale in Terræ Gremio generatum, vel potius Animal Putrefactum? Equidem nemo Rerum Physicarum non prorsus imperitus inficias iverit, dari ejusmodi Fossilia seu Mineralia, Calvariarum Prægrandium, Dentium Ostiumque specie efficta: Et quomodo Natura tam Immanes Calvarias, tam Immania Humani (adde & Animalis) Corporis Membra, ad Femorum, Tibiarum, Costarum, Dentium, similitudinem producat, omnium optime clarissimeque explicatum dedit *Kircherus*, dicens, Latere in subterrestribus visceribus intra saxo-
 forum Montium Iliatus, Terram quandam Limosam, quam Margam cum Agricola
 supra nominavimus, Gypseæ Materia mistam; quæ Terra ubi per Rimas Montium
 Nitrosum Fluorem receperit, fit, ut illa veluti Cortici quodam Gypseo induatur, qui
 uti cum Tempore lapidescit, ita quoque salis Nitri splendore Albedine sua Os prox-
 ime amulatur, utpote Candidum, Rimosum, & Friabile. Si itaque intra Terræ Conca-
 vitatis rotundæ locum invenerit, nascetur Pila Rotunda, quæ discussa Calvariam
 proxime amulatur; si Matrix fuerit disposita sub Forma Femoris Humani (alte-
 riusve Animalis) aut Costæ aut alterius Membri, Marga in ea contenta super affuso
 Sal Nitroso Liquore, Femur Humanum Minus, Majus, Maximum, & prorsus
 Gigan-

Giganteum, pro *Matricis magnitudine exprimet*. Atque hæc sunt *Ossa ista*, quæ *Natura producit*, & passim *Ossa Gigantum communi Hominum persuasione dicuntur*; quæ tamen si confregeris, nulla in eis nec *Medulla*, nec *Medullæ Fistulosus Meatus* reperitur, quod fieri deberet si (*Hominum Animaliumque*) *Ossa forent*. Has *Observationes* suas certissima *Experientia Kircherus* ipse confirmat, visis ab se in pariete antri *Panormitani* *Dentibus* parvis, mediocribus, maximis & excessivæ *Magnitudinis*, ea serie, qua *Natura Maxillis Animalium* inferere solet, infixos tanta *Copia*, ut centum *Carros* inde onerari posse facile crediderit: alibi protuberabant *Vertebrarum*, *Genuum*, *Tibiarum* & *Calvariæ Vestigia*, nullo tamen *Ordinis* nexu, nec quidquam inter omnia *Ossæ Substantiæ vestigia*, organizatum uti sunt *Caput*, *Manus*, *Pedesque* reperiebatur; unde luculenter admirabilem *Naturæ* in *Ossibus*, aut *Ossibus* similibus *Saxis* formandis *Industriam* primo se cognovisse fatetur *Kircherus*, in *Marchione Ventimiglia*, *Lustrationis Comite*, duo edoctus, nobis maxime proficua; quorum alterum est, in *Agro Solonio* juxta *Mare*, *Drepanum* & *Panormum* inter, ab *Agricolis* vera adhuc erui *Ossa Elephantum*, qui præteritorum seculorum *Temporibus* ab *Afris*, in *Siciliam* contra *Hostes* in *Bellum* educti, ibidem interfecti tumulati sunt, poscens *Temporibus* tandem detectis *Ossibus*, quæ & imperiti passim pro *Gigantum Ossibus* venditant: Alterum, hoc discrimen esse inter *Ossa vera* & a *Natura Minerali* producta, quod illa semper *Tibiarum Canales*, *Fistulososque Meatus* olim *Medulla* refertos retineant. Hæc vero solidum *Lapidem* sine ulla *Tibiarum Concavitate* mentiantur. *Tonnensia* verum tantum abest, ut *Meatibus Medullaribus* careant, aut ne reliquas *Kircheri Regulas* omittamus, nullo *Ordinis Nexu* inter se jaceant, nihilque *Ossum Organizatorum* contineant, ut potius ea omnia ibi luculentissime extent, omniumque *Oculos* incurrant.

Quæcumque enim in *Elephanto* sunt *Ossa concava & fistulosa*, medullisque referta, ea in nostro etiam *Scelecto* paria faciunt: Nec turbare nos debet *Exertorum Dentium Soliditas* ad eam usque partem, qua in *Maxilla* figuntur, quippe in maximis *Nativis* etiam deprehensa. Omnia porro isto *Ordine* inter se connexa sunt, quem *Natura* requirit, situ violento & extraordinario non impedita; *Ossa* quæ *Kircherus* *organizata* vocat, & inter *Mineralia Antri Panormitani Ossa* frustra quæsit, nostro *Scelecto*, ne minimo quidem excepto, quod ex reliquiis colligitur, perfectissime comparuerunt.

Cranium sane *Cellulis* pro *Vasis Nervisque* transmittendis curiosissime distinctum est, nec *Cavitate Cerebri*, *Medullæ Spinalis Processu* destituitur: *Dentes Exerti* nativum *Colorem*, *Lævorem*, *Strias*, *Tubulos*, *Interstitia* sive *Cortices*, referunt, imo dexter ab *Animali vivo* limatum se prodit: *Maxillaris Descriptioni Raianæ* optime convenientes sua gaudent *Gomphosi*; seu *Cavitatibus Sinuibusque*, quibus *Maxillæ* inserti fuerunt, *Medulla rubicunda* petrefacta adhuc repletis; *vertebræ Colli acuminato Vertice præditæ*, & *Ossa Tarsi*, sibi invicem respondent: *Capita maxima* seu *Globi acetabulis* suis, *Costæ Spinis Dorsæ* juncta fuerunt. Nec plura ex præcedentibus repeto, cum hæc altius expensa cuilibet persuadeant, non posse *Naturam ludentem* sibi que relictam, nec *Animali* ejus *Partes* sunt concurrentes, *Corpus ejusmodi Organicum* omnibus numeris absolutum formare: aut si quis regere soluerit, dari nonnulla *U-*

nicornua Fossilia vulgo dicta, & Mineralia, quæ fistulosos Meatus habent, illi ex Kircheri Principio, in ipsa Experientia fundato, facile reponerem, Fossilia isthæc non ex Mineralium, sed Animalium Genere esse, contrariam Sententiam probandi Onus eidem relinquens. Inviçtum enim Argumentum est, quod in Conjecturis de Antiquissimo Statu Helmstadii, p. 13. proponit Conringius: *Posse vero Naturam, relictam sine omnibus adminiculis, Ossa undequaque perfecta condere qualia in Fœtu primum conformantur, deinde in Adultis diuturna Nutritione Animali perfici solent, id vero est ἐν τῷ ἀδυνάτῳ.* Eoque solius Naturæ luxuriantis Lusui tribuere, confectionem tot in Usus Vitæ conformatorum & omnibus modis absolutorum Ossium utique sine Nota Summæ Absurditatis haud licuerit.

Accedit alterum Argumentum non minoris ponderis, quod eodem loco Kircherus nobis suppeditat, dicens, *Margam* pro diversa Cavitatis, seu Matricis in Terræ Visceribus Dispositione, diversa Ossium Simulacra producere. Licet itaque in Arenis Tonnenfibus Margam Succumque seu Aquam Lapidescentem, quæ Kircheri Fluor Nitrosus audit, recondi facile concesserim; tamen quis unquam sibi imaginabitur, Cavitatem seu Matricem ita ibi olim dispositam, ut *Skeleton Elephantis* Situ extraordinario supra descripto injectum representarit, quam postea Marga fluens fortuito deprehensam repleverit, Temporisque successu in istam excreverit Molem? Certe influit eadem Natura, eadem Materia, idem Calor, idem Humor, idem Fomentum Terræ, eadem generandi Ratio, sed diversissima Producta sunt pro diversitate Ossium Elephantis genuina; quatenus sunt in Capite cellulis distincta; in Dentibus Maxillaribus Vitri instar dura & candentia Striis undulatis prædita; in Cornubus sive Dentibus Prominentibus Lævia, Flavescencia, in Cuspide Limata, Striata, Tubulis ac Interstitiis conspicua; in reliquis Ossibus porosa: & plane ad normam rationemque Corporis organici formata? Quis, inquam, rebus sic stantibus, illam in Sententiam se unquam abduci patietur? Nonne multo est verisimilior altera Anselmi Boetii de Boodt, Rudolphi II. Imperatoris, Archiatri, in *Historia Gemmarum & Lapidum*, Lib. 2. Chap. 242? qui postquam docuerit, Margam lapidescente & subterranea Aqua fluente irrigatam vel solutam, Lactis instar fluere per Terræ Cavitates, absorptaque seroflore Aquæ parte, crassiorem Cavitates implendo fisti, & absumpto Humore omni coalescere, lapidisque Formam & Cornuum præ se ferre; quæ Kircheri aliorumque communis est Opinio: Subjicit; *Verum si Lacteus hic Humor non in Cavitatem, sed in Lignum aliquod vetustate arefactum incidat, illiusque Corpus jam leve & porosum subeat, tandemque vel exhalata Aquæ tenuioris portione crassior remaneat, tandem coagulata Lignum transmutat, ejusque partes sibi assimilat, ita tamen, ut Species Ligni nosci, & interdum Odor deprehendi possit. Quod Ligno contingit, id etiam Cornubus Cervinis, Dentique Elephantis, aliisque Quadrupedum partibus, si in hujusmodi loca decidunt, contingere potest.* Hinc fit, Cornua ista Fossilia inter se multum differre, & pauca eandem faciem ostendere, imo aliqua Dentes, Tibias, Maxillas, aliasve Corporis Partes referre. Hanc Sententiam proxime ad Veritatem accedere judicat Olaus Wormius in *Musæo*, pag. 54. Quid igitur vetat, Epicrisi horum Doctissimorum Medicorum acquiescere, modumque, quo in Petram conversa sunt Ossa Elephantis Tonnenfis, verbis

verbis eorum exprimere, præsertim cum non solum *Dentes Elephantis*, sed alias quoque partes quadrupedum, (quidni & omnium maximi?) hac ratione mutari posse disertissime fateantur.

Devenerat igitur quovis modo ac tempore (de quo infra dispiciemus) in Collem arenosum *Tonnensem Elephas*, cujus *Ossa* temporis longitudine arefacta calcinavit Ignis subterraneus, eaque jam *Lævia* & *Porosa* subiit *Lactens* ille *Marga* Humor, & exhalata *Aquæ* tenuioris portione crassior remansit, (cujus particulas in *Ossibus* porositis ob majorem Albedinem ab eorum Substantia facillime discernere licet) & tandem coagulata totum *Elephantis Sceleton* transmutavit, ejusque partes sibi assimulavit, ita tamen ut *Species Ossium* interna & externa nosci, & forte etiam *Odor* deprehendi possit. Ultimum de *Odore* subdubitans adjeci, quoniam tentare nondum licuit. Si tamen *Boetius* odorem intelligit, quem *Ligna* & *Ossa petrefacta* in *Furno Chymico* spargunt, id de novissimo Examine adseverare possum, quod Nares propius admoventium idem prorsus adflaverit *Odor*, quem *Ossa*, Cornuaque adusta dare solent. Aliquot *Eboris* sive *Dentium Elephanti Fossilium* Exempla protulit *Bartholinus* proptremo de *Unicornu* Capite, in medio quidem relinquens, num *Dentes* fuerint in *Lapideam* duritiam compacti *Ætatis Moræque* Ambitu, an ex prima *Lapidum Mole* incertam tantum *Dentis Cornuve* Figuram effecti a *Natura*; Fassus tamen, utrique suam esse rationem, si alterutrum nolis; neque spernenda *Petrefactionis* exempla *Causasque* adjiciens. Ad eundem modum hæsitabundus pronunciat de *Dente Maxillari Elephantis*, alteroque *Rosmari* in *Petram* seu *Silicem* conversis: *Nostram* tamen *Sententiam* differte amplectitur alioque *Rosmari Dente* illustrat *Medicus Islandus Arngvimmus*. Eidem apertius favet *Antonius de Pozzis*, *Archiatr Casareus*, in *Epistola* ad *Lambecium*, quam ipse *Lambecius* una cum figura *Dentis Elephantini Maxillaris* Tomo VI. *Commentariorum de Bibliotheca Casarea* appendit, p. 315, 316. Is enim non solum *Dentem* istum, sed & *Femoris Tibiarumque Ossa Badena* reperta, pro veris *Elephantis*, sed *Petrefactis*, habet; Addito *Ratiocinio*, quod si *lapideam* mentiatur *Naturam*, hoc accidit a *Terra*, cui sepeliuntur, occultis *Conatibus*, quæ suo *Concentrato Archeo* *Semina* extrahit *Lapidificationis* atque indurat. Plura ejusmodi *Elephantina Petrefacta* in *Romanis Cimeliis* ex *Celeberrimi Ciampini* *Observatione* colligo, quam in *Ephemeridibus Naturæ Curiosorum*, An. 1688. p. 446. deprehendi.

Refert enim *Ossa* quædam miræ *Magnitudinis* effossa, *Femoris*, *Scapulae*, & *Vertebrarum* quinque, inter quas erat illa *Cervicis*, quæ *pondere* simul 180 *Libras Romanas* excedebant; & a plerisque pro *Giganteis* habita, cumque aliis ejusmodi in *Urbis Cimeliis*, *Chisiano* præsertim, collata, omnium maxima erant. Dubio autem exorto, an *revera Gigantis*, aut potius *Elephantis* essent, ad *Eruditum Amicum Florentiæ* commorantem data fuerunt *Litteræ*, ut *Exemplar Sceleti Elephantis*, qui in *celebri Medicorum Musæo* visitur, mittere non dedignaretur, qui *Petitioni* benigne annuens, *opratum* transmisit *Exemplar*, quare facta cum *Ossibus Collatione Unanimi Consensu* judicatum fuit, tam illa noviter reperta, quam in *Cimeliis* asservata *Elephantum* esse, & pro certo habuimus, illorum *Elephantum* fuisse, quorum

Plinius

Æt. Med.
Hafn. Tom.
I. pag. 83,
84.
Ib. Tom. 4.
p. 182.

Lib. 8. Cap. 2. & 6. *Plinius* meminit : Addit *Ciampinus*, varia deinde alia Ossa Lapidifac̃ta, Dentefque Fossiles collata fuisse.

Non diffiteor, optime *Magliabechi*, cum mihi de *Ossibus Tonnenfibus* cogitanti hæc in Mentem redirent, primum inde ortum Consilium, rem totam tibi exponendi, quod spe teneret haud infirma, Litis Romanæ Sceleton Mediceo feliciter sopitæ Exemplo, nostram quoque terminari posse. Ratum interim firmumque esto Sceleton Elephanti Tonnenfis pristinam Ossium Naturam Calcinatione subterranea, Philosophicæ Analoga, maximam partem perdidisse, adeoque Ossium Calcinatorum instar friabile esse, ac insigni astringendi Robore pollere. Equidem si Ebori nativo astringens vis est, quæ tamen Gustu non percipitur, ut *Aldrovandus* adnotavit, quidni ea potius se exerat linguæq; adhereat in ebore, tot annis in terræ gremio latente, calcinato & maximam partem petrefacto ? Neque enim Ossa nostra in Lapidem ita conversa sunt, ut nulla Ossa Naturæ intrinseca remanserint Indicia, quæ Examine Chymico per Ignem instituto extorqueri possunt. Id sane cum apud nos susciperetur, non solum in Vase Fictili, quod Retortam vocant, remanserunt frustula Ossium injecta, & Colorem Figuramque Spodii, & Odorem Ossis Cornuque adusti manifeste referentia ; sed etiam Phlegma vitreo Vase, cui Recipientis Nomen exceptum, *Sal Volatile* Gustu & *Oleum* pinguedine tenui innatante prodiderunt. Postea Particulæ istæ Ossium in Figuli Fornace fortius Calcinatæ, Albo Colore præditæ, Tubulos Striasque Dentium Elephanti aperte monstrabant ; tam elutriatæ & inspissatæ, ut Chymicorum Vocabulis utar, tam in Sedimento, seu Lixivio, *Sal ChrySTALLINUM* continebant, quam in Phlegmate Saporem multo acriorem Linguæ gustandum præbebant, Oculis jucundo Spicularum Salinarum innatantium Spectaculo relicto. Quæ omnia quidem ex Ossibus Cornubus, quæ Animalium quotidie eliciuntur, nulla tamen hujus generis ex Lapidibus, Margis aut Osteo Collis erui possunt, cum Lapides ne calcinari quidem sese patiuntur, sed in Calcem Igne degenerent ; cujus Rationem *Kircherus* in exigua Humiditate quærit, qua fit ut Partes spirituosæ Lapidum ob Sulphuris Pinguedinem partes fixas in Calcem resolvant. Quis igitur amplius dubitavit meæ subscribere Sententiæ, faterique, vera Elephanti Ossa Tonnen reperta, sed Igne subterraneo, quem satis prodit Odor Sulphuris Terrestris in Phlegmate Residuisque Particulis calcinata, & maximam partem petrefacta ? quæ causa est, quod nec *Sal Volatile* nec *Oleum* ea Quantitate sperare inde liceat, quam Ossa Recentia suppeditant ; idque magis, cum in his etiam, ex Medici Angli *Cloptoni Havers*, in novissima *Osteologia*, Observationibus, *Sal Volatile* vix tregesimam, *Oleum* non multum ultra vigesimam quartam, Ossium partem constituent ; tantillum vero in Ossibus Lapidifac̃tis fere absorptum, ejusque vix super esse vestigia, quis iverit inficias ?

Cæterum alius nonnullis eximendus restat Scrupulus, qui negant, ullum in Rerum Natura Elephantem unquam fuisse, cui tantæ Magnitudinis Ossa convenient. Enimvero hos ego jubeo securos esse, & India Africaque Itineraria adire : in quibus non solum Tantæ, sed Majoris etiam Proceritatis Elephantos reperient. *Hybernicus* quidem *Moulini*, ad cujus Normann

nostrum

nostrum sæpius exigimus, vix major fuerit *Antwerpiensi*, quem *Goropius Becanus* apud *Aldrovandum* accurate dimensus est, ejusque Altitudinem octo Pedum reperit. In *Scelecto* autem *Hybernico* Longitudo Ossis innominati est 25, Femoris 28, & Tibiæ 19 Digitorum, qui simul efficiunt 72 Digitos, sive Sex Pedes; his duos addo Pedes pro explendo spatio, quod *Planta Pedum*, *Curvatura Dorsi*, *Cartilagine*, *Caro* denique & *Cutis* requirunt: indeque colligo, quam dixi, *Hybernici Elephanti Octopedalem* Altitudinem. Cum vero Collatio supra instituta docuerit, *Tonnensis* *Ossa* ad minimum altero tanto majora fuisse, inde simul conficitur, *Sedecim* circiter *Pedum* Altitudine illum eminuisse. Hæc autem tantum abest, ut insolita sit, ut potius *Julius Caesar Scaliger* Exercitatione 204, eandem diserte notaverit, ex *Indicarum* Navigationum Scriptoribus referens, *Elephantos Senum Denum Pedum* excedere Proceritatem. Sed dantur longe majores *Joannes Jacobus Saar*, in Itinerario refert, certum *Mensuræ Genus*, *Gobdel* appellatum, tres partes *Ulnæ* (*Norinbergensis*, ut arbitror, propter Auctoris Patriam) æquans, & Trecentorum sive Quadringentorum *Imperialium* Prætio æstimatum, cui vendibiles *Insulæ Ceylon Elephantæ* subjiunt, Altitudine 7, 8, 9, 10, & undecim *Gobdel*, neque majores sibi visos esse. *Ulna* autem *Norinbergensis* 4 circiter Digitis superat duos illorum *Pedum* quos hætenus adhibui; unde sequitur *Mensuram Gobdel* circiter esse 21 digitorum, adeoque maximum *Elephantorum Saario* visum plusquam 19 *Pedum* Altitudinem habuisse. *Philippus Pigafetto* in Descriptione Regni *Congensis Africani* Fidem facit, Vestigia maximorum ibi *Elephantorum* in *Diametro 4 Spithamas*, quæ duos *Pedes* & 8 *Digitos* referunt excedere; in *Elephantum Antwerpiensi* *Calcis* sive *Plantæ* imæ *Diameter* *Pedis* unius & duorum, paulo plus minus *Digitorum* erat. Collato utroque *Diametro* deprehendemus, maximorum in *Africa Elephantum* Altitudinem 18 *Pedes* superare. Sed inde simul liquet *Hodienum Elephantos Indicos Africanis* majores esse, quod *Aldrovandus* & *Bochartus* ex antiquis probant Scriptoribus. Nec dubito, quin ex *India* fuerit allata *Costa Elephantum*, quæ *Anatomico Academiæ Leidensis* Theatro ostenditur, juxta exteriorem flexuram 8 admodum *Pedes* longa, & ubi spississima est, circa *Ossis Sterni* commissuram, *Pedem unum* cum tribus *Unciis* circuitu suo implens, a *Theodoro Rickio* in Oratione de *Gigantibus* descripta, ut longissima *Elephantum Hybernici* *Costa* vix 32 *Digitorum* erat; cumque 8 *Pedes* 96 *Digitos* contineant, sequitur *Elephantum* istum ejus *Costa Lugduni Batavorum* servatur, 24 *Pedes* Altitudine æquasse; ac tales profecto ad minimum fuerint *Elephantum Cosrois*, *Persarum Regis*, ab Anonymo *Arabe* apud *Bochartum* celebrati. Nonnulli duodecim *Cubitos* proceri erant, quod valde rarum est, quia plerique non superant 7 *Cubitos*. Si *Cubitus* in sensu vulgari apud nos accipitur, vix duos *Pedes*, i. e. 24 *Digitos* æquat, eoque pacto hi *Elephantum* ejusdem cum *Leidensi* fuissent Proceritatis: Sed mihi videtur *Cosroes Elephantos* suos *Dimensus* antiquis *Persarum Cubitis*, a *Golio* in *Notis ad Alferganum*, p. 74, 75. ex Scriptorum *Arabi Geodatico* explicatis, quorum singuli *Digitos* 27 comprehendebant. Hoc autem modo quilibet istorum *Elephantum* fuisset Altitudine 27 *Pedum*. O stupendam vereque rarissimam & Regio stabulo dignam illorum proceritatem! Quam quicumque con-

consideravit *Tonnensem* nostrum, plusquam dimidia parte minorem, non adeo mirabitur.

Verum unde tandem in has Terras, Collemque hunc Arenarium pervenit *Elephas* hic, solito saltem major? Hæc sane Quæstio eruditissimi *Magliabechi*, plurimas curiosorum conjecturas peperit, quorum alii a *Romanis* Mercatoribus, alii ab *Attila*, alii a *Carolo magno*, alii a Comitibus *Glichenfibz*, alii superiori demum Sæculo, in hanc Regionem delatum tumultumque finxerunt. At præterquam, quod earum singulæ suis laborant Difficultatibus, quas nunc enarrare supersedeo, omnes certe variis Argumentis simul infringi possunt. Cujusmodi est, quod *Eboris* usus antiquissimos credere non permittit, defosso ibi Elephanto Dentes præstantissimos ac longissimos, haud fuisse ademptos; nec tantæ Proceritatis Bellua ex *India* vel *Africa* facile transferri antiquioribus temporibus, aut recentioribus circumduci potuit; & ab aliis observatum est, non Seniores Ætate, sed Juniores, in *Europam* deportari; multo minus quisquam in mortui *Elephantis* Gratiam tantæ profunditatis, 24 Pedum, foveam fieri curaverit. Maxime autem illis adversatur ipsa Montis arenosi Ratio, quæ diligentius inspecta nunquam se perfossam, & deinceps rursus repletam, manifestissime prodit. Primum stratum supeditat Humus atra 4 Pedum; succedit Glarea friabilis duorum & dimidii Pedis, cujus medium *Osteocollæ* *Tofaceique* *Lapides* duorum Pedum Altitudine explent, ut & sub ea dimidii Pedis spatium; sequitur *Argilla* arenosa 6 circiter Pedum, in qua iterum *Osteocollæ* duorum Digitorum, & infra unius Pedis Altitudine occurrit: hanc excipit alterum Glareæ stratum 6 circiter Pedum; eique demum subjacet Arena alba & pura, cujus Profunditas nondum explorata est, quod in ea, vix tres Pedes effossa, *Elephantis* *Skeleton* apparuit. Enimvero si unquam perfossus injectoque *Elephante* repletus iterum fuisset hic Collis, minime strata stratis ordine imposita; sed omnia illa Arenarum genera Terræ nigræ permixta inveniremus, ut quotidie in *Tumulis* fodiendis fieri solet. Multo minus *Tofacei* *Lapides*, in hanc duritiem coalescere, aut *Osteocollæ* Radices suas Venasque per totum Montem ad ipsum usque superficiem conspicuas, spargere, tantæ Quantitate crescere, potuissent, ut statim in medio primæ Glareæ, quæ Atram Humum proxime contingit, duos Pedes, & sub ea *Dimidium* explerent seque inferius in *Argillam* arenosam extenderent, spatium duorum Digitorum & sub ea Pedis unius occupantes. Nihil igitur superest, præterquam Universale Diluvium, in quo periit cum aliis sui generis diversique Animantibus, *Elephas noster*, undique immanibus raptus & jactatus, Aquis tandem decrescere incipientibus, fundum petiit; cui Aquæ ista diversarum Arenarum Strata induxerunt; iisque in Superficie exsiccatis, *Atra* tandem *Humus* sensim accrevit. Quemadmodum enim *Diversa Arenarum Strata* satis probant, Collem *Tonnensem* ex Diluvio Originem trahere; ita Altitudo Terræ Nigræ idem confirmat. Utrumque breviter ostendendum mihi video.

Prius faciam præclaris Observationibus, a *Nicolao Stenone*, Medico apud vos quoque celebri, in Dissertatione de Capite *Canis Carcharia* Dissecto, quam *Myologia* Specimini adjecit, suppeditatis, quas tamen omnes describere, vetat *Epistolæ* Ratio. Loquitur quidem ille præcipue de *Aquatilium* *Animan-*

tium Partibus, uti sunt *Ostreorum Testæ & similia*, cum ex Terris eruuntur : Sed nihil prohibet de *Terrestrium* quoque Animantium partibus eo modo effectis idem pronunciare. Etenim Colli *Tonnenfi* applicari plane possunt, quæ *Steno* refert de Terra, unde Corpora hæc eruuntur. Nam & iste quibusdam in locis durior est, *Tophumque & Osteocoliam* continet, in aliis mollior, *Argilla Sabulorumque* refertus, compositus ex stratis sibi mutuo impositis, & ad Horizontem obliquis. Bene autem arguit *Steno* ; Terram mollem spectat, cum eo meliora sunt Corpora illa, (nos Elephantis nostri Ossa subaudiamus) minusque contactum ferant, quo profundius latent ; tantum abest, producat ea Terra, ut potius eadem destruat : Nec est, quid quis credat, ideo molliora ea esse quia nec dum perfecta sunt ; quæ enim mollia sunt, dum generantur, quodam quasi Glutine unitas inter se partes continent, (ut videre est in Recentibus Pinearum & Amygdalorum Corticibus :) at hæc corpora omni Glutine privata in Pulverem dilabuntur, adeoque Mollities ea Destructionis, non Productionis, Argumentum videtur. Quæ in sequentibus disputat *Steno*, Terram istam non fuisse compactam, cum prædicta Corpora ibi producta sunt ; eamque Aquis olim non solum tectam, sed plane immistam, imo pro Aquæ sedimento sensim congesto, habendum esse nullo negotio ad Collem *Tonnensem* referri possunt : mihi tantum excerpere quædam placet, ex p. 211, 212. Quod Argilla & Sabulum Aquæ vehementius agitata immisceantur, præceptum Torrentium per id Generis Terras prolapsus, & Aquarum a ventis agitatio, notius reddidere quam quod pluribus exponi mereatur. Nec probatu difficile est, in Aquis stagnantibus, imo in limpidissimis Aquis, Sabulum, Argillam, & Tophos, omnisque Generis Solida sæpius delitescere. Quis ergo amplius dubitaverit, Collem *Tonnae Arenarium* ex Diluvii Sedimento superesse ? Plura hanc in rem ex Terræ Visceribus petita Argumenta suppeditat *Jacobus Grandius*, Medicus *Venetus*, in Epistola de Veritate Diluvii Universalis, & Testaceorum, quæ procul a Mari reperiuntur, Generatione, è quibus tantum tria priora excerpere juvat. I. In multis Montibus altissimis non solum Europæ & Asiæ, sed etiam Africæ & Americæ, extant certa Vestigia Maris, quod illic Sedimenta deponens Strata produxit Uniformia, & Horizonti Parallela, quod nulla Ratio suadet contingere potuisse, nisi tempore Diluvii universalis. II. Idem testantur longissimi Terrarum Tractus, obducti variis Collibus Arenosis, ex Alluentis & Turbidi Fluidi Sedimento ortis, & magnam cum Maris Fundo similitudinem habentes. III. Magna Apertura Montium, Fluminum, atque Torrensium Corrosione facta, ostendunt diversa solida ex affuso & supernatante Fluido, diversis modis diversa corpora comprehendente atque lapidescente, producta ; itemque varia Sedimenta sibi invicem imposita, Veris Conchis, & aliis Marinis abundantia.

Cæterum, de *Atra Humo* post Diluvium Terræ adnascente, multa Peculiaria observavit *Olaus Rudbeckius* Medicus *Suecus*, Tom. I. *Atlantica*, Cap. VI. quæ aliis quoque doctissimis probata Viris nunc transcribere nihil attinent : ad nostrum tamen Collem *Arenarium* si applicare placuerit, sciendum prius est, in illis quidem Sylvæ *Thuringica* Montibus, qui Metalla continent, & ex durissimo constant saxo, *Atram* istam Humum duorum circiter Pedum deprehendi, multoque tenuiorem pro montium Declivitate : Aliis vero in Locis quatuor Pedes æquare vel excedere, cum

primum in Vallibus, quæ illam Pluvia ex montibus ad se derivatam exceperunt. Quod uti facit ad Rudbeckii desiderium Altitudinem *Nigra Terra*, in Regionibus *Sueciæ* Calidioribus, & Pluvia copiosiora irrigatis nosse cupientis; ita vicissim ostendit, Altitudinem ejus quatuor *Pedum* in Colle *Tonnenfi* a Diluvii Tempore haud frustra derivari, indeque evinci, nullum *Elephantem* ibi postea sepultum esse. Quid autem vetat, his exteris Medicis *Germanum* jungere, *Hermannum Conringium*, qui in Conjecturis de antiquissimo statu *Helmstadii* & Viciniæ, nostras quoque Regiones *Diluvio* inundatas probaturus, Triplici potissimum Argumentorum genere pugnat, ex *Marinis Conchylis*, *Ossibus Belluarum*, & *Arboribus* sive integris sive partibus, quæ cum in altissimis Montium jugis tum sub *Terræ* locis profundissimis reperiuntur, petito: nec ea inter præterit *Sudem in Sepis usum paratam*, *Cornu item uri*, quæ *Thuringi* profundissimis *Saxorum Cavernis* reppererunt, quorum istam *Salze*, quæ vix unius *Horæ* Spatio *Tonna* distat hoc in Monte *Seebergensi*, *Gothæ* nostræ Vicino (unde etiam *Conchylia* elegantissima eruuntur) extitisse memorat *Albinus* in *Misnientium Montanorum Chronico*, Tit. 22. n. 7. quibus addi forsitan merentur *Arborum Folia*, *lignorum Fasciculi*, & *Spicæ Culmis* adherentes, quæ omnia petrefacta in *Lapidicina Tonnenfi*, non admodum procul a Monte nostro, reperta sunt. Singularis quoque est *Conringii* Observatio, his Verbis, p. 37. expressa: *Sunt porro Arbores illæ fere omnes uno quasi eodemque collocatæ situ, Radice nempe inter Septentrionem & occasum, Cacumine inter orientem & meridiem porrectis, cujus causam non profecto ulla vere similitudine dixeris Jocantem Naturam. At prostratas Arbores a Paludosa Terra, per Oceani Septentrionalis Cœcia aut Cauro, Ventis agitati superjecta, id saltem quam similitum est vero: Præsertim quum ex illa Cœli Plaga & illis Ventis savientibus, hodieque omni Germanicæ Maritimæ Oræ, pericula inundationum plerumque creari soleant.* Novum hinc mea Sententiæ accedit Argumentum, quoniam *Elephas noster Cornua* sua versus Ortum ac Septentrionem protendebat: & quanquam id paulo diversum videtur a *Conringiano*. Notandum tamen est, tantum *Belluam* Mari abreptam sese varie movisse, *Arbores* autem eodem, quo prosternuntur, Situ obrutas jacere. Cæterum *Elephantem* Undis immanibus agitatum non mirum est. Situm plane extraordinarium Violentumque tandem aquisivisse, ejusque Membra putrefacta latius extensa: Nec alia forsitan de causa *Dentes* exerti sive *Cornua* in trorsum incurvata fuerunt, quanquam eorum situs in delineatione capitis *Hybernici* apud *Moulinum* similis fere deprehenditur; accuratius procul dubio expressus, nisi pleraque eorum pars adusta fuisset; ut proinde potius a Morte vel Putredine, quam undis fatalibus id derivandum videatur.

Mineral
Maps, By
Dr. M. Lister.
p. 164. p. 739.

XXXVIII. We shall then be better able to judge of the Make of the Earth, and of many *Phænomena* belonging thereto, when we have well and duly examined it, as far as human Art can possibly reach, beginning from the outside downwards. For this purpose it was advisable, that a Soil or Mineral Map, as I may call it, were devised. It might be distinguish'd into Countries, with the Rivers and some of the noted Towns put in. The Soil might either be

be coloured, or otherwise distinguished by variety of Lines or Etchings ; but the great Care must be, very exactly to note upon the Map where such and such Soils are bounded. As for Example, in *Yorkshire*, 1. The *Wolds* ; *Chalk*, *Flint* and *Pyrites*, &c. 2. *Blackmoore* ; *Moors*, *Sand-Stone*, &c. 3. *Hol-derness* ; *Boggy*, *Turf*, *Clay*, *Sand*, &c. 4. *Western Mountains* ; *Moors*, *Sand-Stone*, *Coal*, *Iron-Stone*, *Lead-Ore*, *Sand*, *Clay*, &c. *Nottinghamshire* ; mostly *Gravel*, *Pebbles*, *Clay*, *Sand-Stone*, *Hall-Plaster*, or *Gypsum*, &c. Now if it were noted how far this extended, and the Limits of each Soil appeared upon a Map, something more might be comprehended from the Whole, and from every Part, than I can possibly foresee ; which would make such a Labour very well worth the Pains. For I am of the Opinion, such upper Soils, if natural, infallibly produce such under Minerals, and for the most part in such Order.

XXXIX. I have some reason to think that Sand was once the most exte-
rior and general Cover of the Surface of the whole Earth ; because all our
Northern Mountains are more or less covered with it at this day, and the
higher the Mountains, still the more, and the coarser the Sand : because
the Rivers arising in the Mountains do yet daily bring it down in great
Quantities. And that it has been so in all probability, in all Ages, since the
first Rains fell upon the Face of the Earth, seems to me to be truth-like, in
that the Sea-Shores, or Mouths of Rivers, are usually barred with it ; besides
the Sandy Sea-Grounds in most Places of the Sea, and which seems a clear
Evidence for the Length of Time (for that the low Ground near these Ri-
vers, which have been in all Ages upon Record, *meffes*) if you pierce so
deep into them, as to discover their Bottom, you meet with this Moun-
tain Sand in great Quantities, and in some Places a Moss under that, and
the same Sand-Bed under that. Now if we consider how long these Mos-
ses or Turf is in growing, it being mostly the Leaves and Roots of Plants,
we must allow very many Ages for this purpose. And altho' *Herodotus*,
one of the most ancient Historians that are, boldly conjectures that the
Nile in *Ægypt*, long before our Times, would be dammed up and useless
by the great Plenty of Mud yearly brought down that vast River ; yet it
does not appear, that the Country is much different from what it was in
his Time : so that the Sand and Mud is still carried to Sea.

Another Argument of the Sand's being the universal Cover of the Face
of the Earth, is, from the great Hardness, and consequently the Durable-
ness and unalterable Quality of this Mineral, above any other in Nature.
For tho' many things are called Sand, from the Smallness and little Cohe-
sion, or Dryness of the Grains, yet this Kind of Mountain-Sand, above all
others, keeps its natural and original Magnitude ; and is not made (as most
Sand is) by the Attrition or wearing of one Particle of Stone against ano-
ther, but is of a constant and durable Figure : and therefore I say, it seems
to me, for this reason, to be the most fit for an Outside or Cover to the
Globe of the Earth.

It may be objected, that the uppermost Beds of Stone on the *high Wools* all over *England*, are soft *Chalk*, and on the smooth Surface no Appearance of *Sand*. This indeed is in part granted : but that there is no where any *Sand* upon the *Chalk Mountains*, is not true ; for to instance in those inland *Sand Hills*, above *Bulloigne* in *Picardy*, which *Sand* is the very same with that on the Sea-Shore at *Calais*, and although this is not in *England*, yet the Sea hath but accidentally divided us. For from *Dunstable* in *England*, even as far as the Walls of *Paris* by *Calais*, is, as it were, a continued *Wools* of *Chalk* and *Flint*. What Difference there is betwixt the *Woold's Mountain-Sand*, and that of the *Northern Mountains*, will best appear in the Table. Now the Nakedness of the *Wools* is from the Smallness of its *Sand*, which readily yielded not only to the *Rain* that fell, but to the *Wind* also. Which is evident from that vast Tract of *Sandy Hills*, which bound the Coast of *France*, *Flanders* and *Holland*, and which have made their Coast so shallow in respect of ours, as being in great part blown off the *Yorkshire*, *Lincolnshire*, *Suffolk*, or *Essex* and *Kentish Wools*, and wrapt up upon their Coasts : and the Reason of this is partly from the more constant *Westerly Winds* blowing over from our Coasts ; and also from the meeting of the two Tides, viz. That of the *Channel* and that other of *North Flood* upon their Coasts.

I am very well aware, that the finding of *Cockles* or *Shells*, as most Writers are pleased to call them, upon Mountains, and *Sand* also there, is by the same *Herodotus* used as an Argument of a great *Deluge*, or *Inundation* of Waters ; but as I have elsewhere, I think, demonstrated, that the *Rock Cochlites*, are no *Shells*, so neither can I grant that the *Sand* was adventitious to the Mountains, but naturally originated there : for that it is there plainly to be found, some loose, and the rest in Beds, yet unloosened, as I could name very many Places ; for instance, on *Silden* and *Thorp Fells* in *Craven*, this Mountain-Sand is a white and transparent Pebble, and as some of it is small, and easily swept and blown away, so is there much of it upon the high Mountains mixt with white Pebbles of greater Size.

'Tis the Character of this *Sand* not to yield to Fire, as *Flint* will do ; and tho' it agree with that and some other Metals to strike fire from *Steel*, yet it does not calcine, as *Flint* will be brought to do. And therefore this *Sand* is the true *Tarso* of the *Italian Mountains*, of which the fine *Venetian Glafs* is made ; and for this Reason the *Flint Glasses* were here in *England* ill compounded, the Foreigners mistaking the Materials, which yet our Country affords in plenty all over the Northern, and (I doubt not) the Western Mountains too : I have seen from the *Scots Mountains* very excellent and large.

A TABLE of Sand (drawn up about the Year 1673.) Such chiefly as I have found in the Northern Parts of Emgland.

Sharp, or Rag Sand, composed of small transparent Pebbles, naturally found upon the Mountains, not calcinable.

Sand	Fine	White	Stitneham-Moor in the Road wash'd up very White Pebble.
			Flamborough Head, of which the Light-House there is cemented.
			Calais Sand burns reddish, but falls not in Water.
	Fine	Gray	Seaton Banks near Hartlepool, on the Tee's Mouth.
		Reddish	Esrick in the Gravel-Pit there; a Vein of exceeding fine Sand.
		Brown	The Pillow-Sand in the Baltick.
	Coarse		In a Spring at Hestington.
			The Sand at the Bath in Somersetshire.
			Acome near York, drifted Sand.
		Grieffly	Hutton Moor Wash.
			Throp Fells.
			{ Owze at York.
			{ Nid. at Mountain.
			Dug up at Rawcliff near Snath.
			Wharfe at Ickly and Denton.
			Air at Carleton in Craven.
		Brown	Eure at Craven.
			Gauton.
			Santon in Lincolnshire.
			Bromeby Common.
			Skipwith Common.

{ At — in Yorkshire.

{ A Vein at Oswell-

{ Bacon in Lincolnshire,

Soft, or Smooth with flat Particles { From Lime- stone with Mica of Glittering Particles.

Of Westmor-
land.

Silver-like

Sea-Sand about the Scilly Islands.

In Cleveland, and about Scarborough.

Ouze Dust or Sediment at Rawliff.

Gold-like

A Vein of Mica in Hestington Gravel-Pit.

Mica Argentea in Red-Sand Rock, near Rippon,
plentifully.

Mica Aurea of Cleveland.

Clay seems to be another Coat of the Terrestrial Globe in the more depress'd and hollow parts thereof. The Mixture of Sand and Clay is not unusu-ally called Earth: Yet this Term being too large, it will be convenient, as I think, to limit it to such a Mixture as we usually find upon the Surface of the Ground; which hath ever in it, besides such Sands and Clays, as ei-ther the Soil naturally produces, or have by Floods and Winds, or other Accidents, been brought thither, a great part of the rotten Parts of Plants and Animals: and in this sense, Turf is Earth, which is mostly where the *Erica* or *Heath* grows, because 'tis made up of the deciduous Leaves of that Plant, which being by the Current of Showers brought together, make up the Moors, Mosses and Fens, and in the Mountains, in hollow Basons or Depressures without Vent, Mosses of incredible Depth; 1 or 2 Fathoms ordinarily in the same kind of black Earth, called *Penn* or *Turf*.

A Table of Clays.

Clay	Pure, that is, such as is soft like Butter to the Teeth, and has little or no Grittiness in it.	
	Greasy, to be reckoned amongst the Medicinal Earth, or <i>Terra sigillata</i> .	
		1. Fuller's Earth.
		Yellowish. { At Brickhill in Northamptonshire. At . . . under the Yorkshire Woods.
		Brown, about Halifax.
		White, in Derbyshire Lead-Mines.
		In Cleveland.
		2. Bili { At Linton upon Wharfe.
		3. Pale Yellow, in the Marle-Pit at Ripley.
		4. Cow-shot Clay, or the Soap-Scale lying in Coal-Mines.
		5. A dark blue Clay or Marle, at Tolthrop.

Clay

Harsh and Dusty when Dry.

Clay

6. *Creta* properly so called, or the Milk White Clay of the *Isle of Wight*.
7. The Porter's pale yellow Clay of *Wakefield Moor*.
8. The blue Clay of *Bullingbrook Pottery* in *Lincolnshire*.
9. A blue Clay of *Bugthorp Beck*, in which the *Astroites* are found.
10. Yellow Clay in the Seams of the red Sand Rock at *Bilbro*.
11. Fine red Clay in the red Sand Rock at *Bilbro* and *Rippon*.
12. A soft chalky blue Clay } at *Buttercrain*.
13. A soft chalky red Clay }

Stony when dry.

14. A red Stone Clay } In the Banks of *Whitear-*
15. A blue Stone Clay } *Beck, near Leppington, and*
16. Clunch, a white Stone Clay in *Cambridgeshire*.

With round Sand, or Pebble.

Mist

17. The yellow Loame of *Skipwith Moor* in *Yorkshire*.
18. A red Sandy Clay in the right hand Bank of the Road beyond *Collingham* near the *Lime-Kilns* going to —
19. A red Sandy Clay in the red Sand Rock near *Rippon*.

With flat or thin Sand, glittering with Mica.

20. Crouch white Clay in *Darbyshire*, of which the *Glass Pots* are made at *Nottingham*.
21. Grey or blueish *Tobacco-Pipe* Clay at *Hallifax*.
22. A Red Clay in the red Sand Rock at *Rotherham*.

XL. These wonderful Sands have not yet exceeded one Century, since they first broke Prison. Their Original is in a Warren in *Laken Heath* (a ^{*Sand-Flood*} at *Downham*, in *Suffolk*; By *Mr. Tho. Wright*. n. 37. p. 722.) Town belonging to the *Dean and Chapter* of *Ely*, distant not above 5 Miles, and lying South West and by West of this Place;) where some great Sand Hills, (whereof there is still a Remainder) having the Superficies, or Swerd of the Ground, as we call it, broken by the impetuous South West Winds, blew upon some of the adjacent Grounds; which being much of the same Nature, and having nothing but a thin Crust of Barren Earth to secure its good behaviour, was soon rotted and dissolved by the other Sand, and thereby easily fitted to increase the Mass, and to bear it company in this strange Progress.

At the first Eruption, I suppose the whole Magazine of Sand could not cover above 8 or 10 Acres of Ground, which increased into 1000 Acres, before the Sand had travel'd 4 Miles from its abode. All the opposition it met

met with in its Journey hither, was from one Farm-House, which stood within a Mile and a half from its first *Source*. This the Owner at first endeavoured to have secured by force, and building of Bulwarks against the Assaults thereof; but this wing'd Enemy was not to be so opposed: Which, after some Dispute, the Owner perceiving, did not only slight the former Works, but all his Fences, and what else might obstruct the Passage of this unwelcome Guest, and in 4 Years effected that by a Compliance and Submission, which could never have been done upon other Terms; in which he was so successful, as that there is scarce any Foot-Steps left of this mischievous Enemy.

'Tis between 30 and 40 Years, since it first reach'd the Bounds of this Town; where it continued for 10 or 12 Years in the Out-skirts, without doing any considerable Mischief to the same. The Reason of which I guess to be, that its Current was then down hill, which shelter'd it from those Winds that gave it Motion; but that Valley being once past, it went above a Mile up hill in 2 Months time, and over-ran 200 Acres of very good Corn that same Year. 'Tis now got into the Body of this little Town, where it hath buried and destroy'd divers Tenements and other Houses, and has inforced us to preserve the Remainder at a greater Charge than they are worth. Which doubtless had also perished, had not my Affection to this poor Dwelling obliged me to preserve it at a greater Expence than it was built. I have at last given it some Check; for by stopping of it 4 or 5 Years (what I could) with *Furze* Hedges set upon one another, as fast as the Sand levelled them (by which I have raised Sand-Banks near 20 Yards high) I brought it into the Circuit of about 8 or 10 Acres, and then in one Year, by laying some hundred Loads of Muck and good Earth upon it, I have again reduced it to *Terra firma*: I have cleared all my Walls, and by the Assistance and Kindness of my Neighbours (who helped me away with above 1500 Loads in one Month) cut a Passage to my House through the main Body thereof.

At the other end of the Town divers Dwellings are buried or overthrown, and our *Pastures* and *Meadows* (which were very considerable to so small a Town, both for Quantity and Quality) over-run and destroyed: and the Branch of the River *Ouse* upon which we border, (being better known by the Name of *Thetford* or *Brandon* River, between which two Towns we lie) for 3 Miles together is so fill'd with Sand, that now a Vessel with two Load Weight passeth with as much difficulty as before with 10. But had not the Stream interposed, to stop its Passage into *Norfolk*, doubtless a good Part of that Country had e'er now been left a desolate Trophy of this conquering Enemy. For according to the Proportion of its Increase in these 5 Miles, which was from 10 Acres to 1500, or 2000; in 10 Miles more of the same Soil, it would have been swelled to a great Vastness.

It is observable, that the Situation of the Country in which this troublesome Guest first took its *Rise*, lies *E. N. E.* of a Part of the great *Level* of the *Fens*, and is thereby fully exposed to the Rage of those impetuous *Blasts* we

we yearly receive out of the opposite Quarter : Which I suppose acquire more than an ordinary Vigour by the *Winds* passing through so long a Tract, without any Check. Another thing which contributes to it, is, the extreme *Sandiness* of the Soil, the Levity of which, I believe gave occasion to that Land-story of the Actions that use to be brought in *Norfolk* for Ground blown out of the Owners possession.

XLII. Besides the *Bolus Armenus*, and the *Terra Silefiaca*, there is an Earth As Hunga-
rian Bolus ;
By --- n.
1. p. 11. found in *Hungary* about the River *Tockay*, thence called *Bolus Tockaviensis*, having as good Effects in Physick as either of the former.

XLIII. Soap Earth is found only in two places near *Duraclea*, a large open The Soap-
Earth from
Smyrna; By
Dr. Edw.
Smith. n.
220. p. 228. Village about 6 Leagues to the Eastward of *Smyrna*; and in a very flat Plain, about a League Westward of the River *Hermus*, and several Leagues from the Sea. 'Tis a fine Soap, and at the first gathering whitish Earth, which boileth or shoots up out of the Earth. 'Tis gathered alway before Sun-rise, and in Mornings when there falls no Dew, so that a Stock must be laid up for the whole Year in the Summer Months. It comes up in some Places an Inch or two above the Surface of the Ground. But the Sun rising upon it, makes it to fall down again. Every Morning there is a new Crop, tho' all be taken away which the preceding Day afforded. The Earth producing it lies low in both Places, and is in the Winter washy; 'tis cover'd, tho' but thinly, with Grass.

Three hundred Drams of this Earth put into a Retort in *Balneo Arena* for 12 Hours cum *Ignis Violento*, gave between 5 and 6 Ounces of an insipid *Phlegma*, the Smell only such as proceeds in such Operations from the Fire.

Finding therefore no *Volatile Salt*, as what must have come over by the foregoing Experiment; 200 Drams calcined at a *Bagnio Fire*, in a *German Crucible*, were dissolved in Water. The Composition of Earth and Water, boil'd into a *Lixivium*, made 500 Drams.

It was boiled for three Hours, still scumming off the Froth, then *Filtrated*, after *Evaporated* over a gentle Fire; it was kept to *Chrystallize*, and appeared of a fix'd Salt.

At the Soap Houses they mix $\frac{1}{4}$ of Earth with $\frac{1}{4}$ of Lime, and dissolve the Composition in boiling Water; where stirring it often with a Stick, there floats a-top a thick brownish Substance, which *Scumming* off they preserve in Basons apart, and this *Scum* is much richer than the Liquor underneath; yet both are used in making the Soap. Into a large Copper Caldron they put 50 Kintals of Oil, applying a very hot Fire, which burns continually until the Soap is made. When the Oil has boil'd, they begin to throw in of the *Scum*, and sometimes of the Liquor from which the *Scum* was taken. They often repeat this throwing in of the *Scum* and Liquor for 13 or 14 Days, in which time the Soap is usually perfected. The brownish *Scum*, and what is useful of the Liquor, incorporating with the Oil, what is useless sinks to the bottom of the Caldron, where it is let out to make room

for throwing in more. The Water thus let out, is again thrown upon a new Composition of Earth and Lime; but when the Liquor becomes wholly insipid, 'tis then judged to be exhausted. After 13 or 14 Days, when the Soap is finished, 'tis laded out of the Boiler, and laid upon a Lime Floor to dry.

They proportion two Load of Earth of five Kintals each, to 50 Kintals of Oil; the Produce is between 70 and 80 Kintals of Soap.

The Earth is bought at a Dollar a Load, and the Soap, when this Account was made, at 6 $\frac{1}{2}$ a Kintal. There is employed in making Soap Yearly at Smyrna 1000 Kintals of Oil.

Bringing Soap-Earth employs 1000, or 1500, Camels daily for eight Months; the four Summer Months being too hot for Camels to travel.

An ordinary Soap-House produces 1000 Dollars a Year clear Profit, *communibus Annis*.

*The Use of
Turkish Rus-
ma; By Mr.
Smith. n.
243. p. 295.*

XLIII. This black Earth, which is call'd *Rusma*, and seems as if it were burnt, must be beaten in an Iron or Marble Mortar to a fine Powder, and sifted diligently; when you use it, take one part of the said Powder, and two parts of unslacked Lime; put these mix'd together into a Linen Rag, which infuse in warm Water the space of a quarter of an Hour, or till it becomes of a black Colour, then apply it to the Place from whence you would take the Hair; as soon as the Hair begins to be loose, the Part must be washed with warm Water and Soap.

*Coal Mines
in Somers-
setshire; By
Mr. J. Beau-
mont. Ph.
Kil. n. 1. p. 6.*

XLIV. Within 5 Miles Northward of *Stony Easton*, there are 6 distinct Coal-Works. The chiefest Observables I met within them, are,

1. The Branched Clift, which usually lies over the Coal, and is all wrought with the Representations of sundry sorts of Herbs.

2. A Clift all interwoven with *Arborescent Marchasites*, which commonly lies over the former, and is call'd by our Colliers the Thorny Clift.

3. We here observe, that some Coal Veins are much more tinged with Sulphur than others; a Vein being wrought in one of these Works some Years since, which received such a Resplendency from its Sulphury Tincture, that in all its Joints it seemed as though it was covered with leaf Gold, and hence by the Colliers it was called the *Peacock Vein*.

4. I may here take notice that about four Years since on one of these Works was found about 2 or 300 Weight of very good *Lead Ore* growing to a Vein of Coal, the Ore being tinged somewhat Yellow by the Sulphur: We look upon this as a Rarity with us, none ever having been found in a Coal Pit before; the Sulphurous Spirit being there generally too strong for the Generation of that Metal.

*A Subterra-
neous Fun-
gus; By Mr.
Jeslop. n. 100.
p. 6172.*

XLV. 1. The *Fungus Subterraneus* I sent you a large Quantity of, was gotten in a Rocky Lime-stone Ground, on a Common about two Miles distant from *Castleton* in the Peak of *Darbyshire*, 15 or 16 Yards deep, in the *Old-Man* (as they call a Mine formerly wrought and stopt up) cover'd with

with Earth, and that had either fallen or was thrown in. There is no Coal-Bed, that is known of, within 5 or 6 Miles of the Place.

2. The Pieces of this *Fungus* which I received, are much like *Peats*, or *Turf*, cut up in the high Moors, both in the Sooty Colour and inward Substance; this only is more Clammy and Tough, and dries not. And some of this *Fungous* Substance is very Soft and like Gelly. In and about the more solid Pieces, (of which I have some half a Foot square) are many big Lumps of a *Bituminous* Substance. This *Bitumen* is very Inflammable like Rosin; it is very light, it breaks firm, and shines like good *Aloes*; and for Colour it is not much unlike it, save that it is more dark-colour'd and purplish; yet there is much of it of a dark green Colour. We distill'd a parcel of it, which yielded us an *Acidulous Limpid Water*; then a white Liquor, which was, I guess, from some of the oily Parts precipitate; and in the last place, a copious yellow Oil, not unlike that of *Succinum*, or Pitch. In the Neck of the *Retort* we could discern no Volatile Salt, as in the like Process upon *Amber*. I have not read of any such *Fungous* Earth, in which *Bitumen* naturally grows and adheres: And the finding of it in an *Old Mine*, doth much favour an Opinion of its being a Vegetable Substance, either the very Substance of the Props of Wood they make use of in lining and supporting the *Grooves*, thus altered, or certain *Fungus's* growing out of them. That Birch, of which there is great Plenty, and hath been vast Woods, all these Mountainous Parts of *England* over, will yield a *Bitumen*, as *Limpid* as the Sap is which runs from it by tapping, if we now had the Skill to extract it. *Pliny* is very express l. 16. c. 18. *Bitumen ex Betula Galli excoquant.* And moreover it is certain that much of that Wood, if not all, which is dug up in the high Moors of *Craven*, and which the People there call and use for *Candle Wood*, is no other than Birch, as it appears from the Grain and Bark; and yet this Wood kindleth, flames, and exudates a *Rosin*, which makes many pronounce it very *Fir* Wood. Whatever this *Bitumen* is, which this *Fungus Subterraneus* yields, it much differs from the *Asphaltum* of the Shops.

XLVI. Mr. *Jessop* sends me word, that Capt. *Wain* has given him a white Liquor resembling Cream both in Colour and Consistence, which he found in great Quantities in the bottom of a Coal-Pit 49 Yards deep. And Mr. *Geo. Planton* writes from *Sheriff Hales* in *Shropshire*, that in the Iron Mines, especially that which the Country People there call the *White-Mine*, which yields the best Iron-stone, the Miners do commonly, upon the breaking of a Stone, meet with a great quantity of whitish Milky Liquor, inclosed in the Center of it; they sometimes find a Hogshead contained in one Cavity. 'Tis in Taste sweetish; only it hath a Vitriolick and Iron-like Twang with it.

XLVII. In *Brosely*, *Bemly*, *Pitchford*, and other Places adjacent in *Shropshire*, there lies over most of the Coal-Pits or Mines a *Stratum* or Layer of a

By Dr. Lister.
ter. ib. p.
6180.

A Blackish
Stone in
Shropshire,
yielding
Pitch, Tar,
and Oil; By
Mr. Martin
Ele. n. 28,
p. 5442.

Blackish Rock, or Stone, of some thickness, which is porous, and contains in it great quantities of *Bituminous Matter*.

This Stone being brought to the Work-House, is ground small by Horse-Mills, such as are used for grinding Flints to make Glafs of; the Powder is thrown into great Coppers of Water, where by boiling, the *Bituminous Matter* is separated from the Stony or Gritty, this last sinking to the bottom, the other swimming at the top of the Water.

This *Bituminous* Substance being gathered together and evaporated, comes to the consistence of Pitch, and with the help of an Oil distill'd from the same Stone, and mixed with the Pitch, comes to be thinner, or like Tar; the Uses of both which Materials, either for Shipping or otherwise, these Substances are said to supply, nay even go beyond. And this has been tried on several Boats this 3 or 4 Years past, and does not crack as the ordinary Pitch or Tar, but always keeps black and soft, and therefore is propos'd to hinder the Worm from getting into the Ships pitched with it.

There is likewise distill'd from this Stone, an Oil which may be used for Oil of Petre, or Turpentine, and has been tried by divers Persons in Aches or Pains.

A Mineral
Balsam in
Alfatia; By
... n. s. p.
335.

XLVIII. In the Valley call'd *Liberthal*, near *Geesbach*, (an antient Mine-Work in *Alfatia*) there runs out of a Cavern a Foul, Fattish, Oily Liquor, which affords an excellent *Balsam*, by taking a Quantity of it, and putting it in an earthen Pot well luted, that no Steam may exhale; and then with a gentle Fire at first, but a stronger afterwards, boiling it for 3 Hours together, in which space it will boil in a 4th Part, and an earthen Matter, like Pitch, will settle itself at the bottom; but on the top thereof, when cold, there will swim a Fatty Substance, like Line Oil, limpid and somewhat yellowish, which is to be decanted from the thick Sediment, and then gently distilled in an *Alembick* in *Arena*; by which means there will come over two differing Liquors, one *Phlegmatick*, the other Oily, which latter swimming on the *Phlegm*, is to be sever'd from it. The *Phlegm* is used as an excellent Resister and Curer of all the Putrefactions of the Lungs and Liver, and it heals all foul Wounds and Ulcers. The Oily Part, being diluted with double its quantity of distilled Vinegar, and brought 3 times over the Helm, yields a rare Balsam against all inward and outward Corruptions, stinking Ulcers, hereditary Scurfs and Scabs. 'Tis also much used against Apoplexies, Palsies, Consumptions, Giddinesses, and Head-aches. Inwardly they take it with *Succory Water* against all Corruptions of the Lungs. It is a kind of *Petroleum*, and contains no other Mineral Juice but that of Sulphur, which seems to be thus distilled by Nature under Ground; the Distillation of an Oil out of Sulphur by Art, not being so easy to perform.

A Mineral
Balsam in
Italy; By S.
M. Antonio.
Castagna.
79. p. 3059.

XLIX. In the Territory of *Bergamo* Sig. *M. Ant. Castagna*, upon the Confines of his *Jurisdiction*, lighted accidentally upon a not ordinary sweet balsamick Scent, which directed him to a *Rocky Hill*, where he found the *Stones* harbour'd that

that Fragrancy, which was so strong, and by Trials found so friendly to the Uterus, that being applied, they did in a very short time cure it of any Evil 'tis subject to. Encouraged hereby, he made his Workmen dig into the very Bowels of the Hill, where he discovered Holes in some Stones, as if excavated by Art, of a greenish Colour, in which he found, as distilled by Nature, and kept in Vessels, that *Liquor* and *Balsam*, which proved the Source of that *Scent*, which was limpid, and of a white Colour, like the White of an Egg, but somewhat *Oleaginous*, floating upon all sorts of *Liquors* like *Oil*. Besides, he met in the same Cavities some small Grains concentered of the same *Liquor*, resembling that which they call *White Amber*, which being chymically distill'd, had the same Odour with the *Balsam*.

L. I find that *Osteocolla* grows in a sandy, yet not gravelly Soil, and not at all (that I know) in any rich or clayey Ground. It shoots down 2 Mens depth under Ground; the Branches most commonly growing strait up, yet sometimes also they spread sideways. The Branches are some of them thicker, some slenderer, and the further they are distant from the common Stem, the thinner they are; the Stalk being thickest of all, usually equalling the Thickness of an ordinary Arm or Leg, and the Branches the Thickness of one's little Finger.

Osteocolla
about Frank-
fort on the
Oder; by J.
Christophe
Beckman. 11.
39. p. 771.

Upon the Sand, which is here every where yellowish, there appears a whitish fatty Sand, which if it be dug into, hath under it a dark, fatty, and (how hot and dry soever the other Sand be) a somewhat moist and putrid Matter, like rotten Wood; which Matter spreads it self here and there in the Earth, just as the *Osteocolla* it self doth, and is called by those whom I have employed to look for it, the Flower of this Substance. The *Osteocolla* being thus found, is altogether soft, yet rather friable than ductile: Wherefore if one hath the Curiosity of getting out of the Ground a whole piece of it with its Branches, he must very carefully remove the Sand every way from it, and then let it lie so a while; its Quality being, that remaining exposed to the Sun for half an Hour, or somewhat longer, it grows to that hardness as 'tis found in the Shops.

It seems to be a kind of *Marle*, or to have great Affinity with it, of which we here have also great Store, yet not near those Places where I have found *Osteocolla*. It requireth also time to come to Maturity, which appears from hence, that in the very same Place where I digg'd some of it last Year, I this Year found other, yet with this Difference, that those grew hard, after the manner before described, but these remain still soft and friable, tho' now in the 5th Month.

The Cause of its being divided into so many Branches, I conjecture to be from the Roots, which spread themselves here and there in the Earth, so that the Matter gathers and settles it self about them, and afterwards according to the Division of the Roots, acquires a plantal Form and Appearance. Whence it seems also to proceed, that thro' the midst of the *Osteocolla* there always passeth a dark Line, which is thought to be a piece of the *R. or*. And it often happens, that the Stroke loseth it self by little and little, and the

the *Osteocolla* in the middle grows clear; which comes to pass when the Root by the Corruption begun in the *Osteocolla* is reduced to Powder. Yet have I found a Place hereabout, where the *Osteocolla* was not hollow at all; but there I observed, that instead of settling about a big Root, it had gathered it self about many small Fibres; whence also this sort had acquired Pores through its whole length, but no Cavity like the other.

Black Lead,
by Dr. Plot,
p. 240. p. 183.

LI. The Mineral Substance call'd *Black Lead*, found only at *Keswyc* in *Cumberland*, and there call'd *Wadt* or *Kellow*; by Dr. Merret, *Nigrica Fabrilis*, from its use in scoring, as the *Rubrica Fabrilis*, or the *Red Ochre* is; is certainly so far from having any thing of Metal in it, that it has nothing of Fusion, much less Ductility; nor can it be reckoned among the Stones, for want of hardness: it remains therefore that it must have place amongst the Earths, tho' it dissolve not in Water, as most Earths will, except stiff *Clays*, and *Ochres*; among the latter whereof I guess it may be reckoned, it seeming to be a sort of close Earth, of very fine and loose parts, so burnt that it is become black and shining, discolouring the hands, as all the *Ochres* do: whence the most proper Name that can be given it, perhaps, may be *Ochrea Nigra*, or *Black Ochre*, being a stony sort, as there are stony sorts of the *Red* and *Yellow Ochres*, as well as *Clay*.

Irish Slate,
by
p. 243. p. 271.

LII. It having been discoursed to the *Philosophical Society* at *Oxford*, by Mr. *Henwrick* Physician at *Worcester*, that the *Irish Slate* pulveriz'd, and infused in Water for a Night or less, would impart its *Vitriolick Quality* so far forth to it, that it would strike of a faint reddish Colour with Powder of *Galls* (as the *vitriolick Waters* of *Tunbridge*, *Astrop*, and divers others do) it led me to believe that these Waters, some of them, might as well issue from *Slate* as an *Iron Ore*, unless it should appear, that this sort of *Slate* were an *Iron Ore* too, which put me upon calcining it for 3 or 4 Hours, after the Manner of Dr. *Lister*, to experiment whether it would then (like other *Iron Ore*) apply to the *Magnet*; wherein altho' I was altogether unsuccessful, the *Magnet* not taking the least Notice of it, yet it afforded me another Discovery altogether as satisfactory, viz. that upon Torrefaction, it was all become a *Yellow Ochre*, and would score like it; which further persuades me, that the *Yellow*, or rather *Orange-colour'd Sediment* we find at the bottom of these *Fountains*, comes rather from this sort of *Slate*, than an *Iron Ore*: for I much question, whether some of the *Yellow Ochres* (tho' it's plain the red ones do) come from, or are *Iron Ores*, because the *Shotover Yellow Ochre* will not own the *Magnet* after 36 Hours Calcination, or better.

Chalk, and
some other
Bodies not
properly
Stones, tho'
commonly
reputed so;
By Dr. Fr.
Slate. n. 182.
p. 114.

LIII. In a small Treatise of the *Calculus Humanus*, I found reason to complain of the Imposition of our Senses upon our Conceptions, in calling that a *Stone* by its external Appearance, when it has no real Properties of a *Stone*. I have also, in this, Reason to except against *Chalk*, commonly taken for a *Stone*, for being brought to the *Hydrostatical Examen*, (if that may be allowed as a Standard) it wants much of the true Consistence of a *Stone*; for it wants

wants much of that weight, which real Stones are proved to have in *Water*, and it may perhaps be better reckoned amongst *Boles* than *Stones*. I found this true not only in Chalk, but various other Bodies taken for granted to be *Stones* at large: Some of which are nearer *Earths* than *Stones*, others have nothing but *Earth*, *Sulphur*, and *Metal*, and yet must be called *Stones*, as all *Marchasites* are; of these the former, (namely the *Boles*) many of them fall short of our Standard of *Stone*, others are more ponderous, and so exceed our Standard: whereas true *Stones*, tho' differing much in hardness, whether *Pebbles*, *Flints*, *Petrefy'd Waters*, &c. do answer the same Standard of *Specifick Gravity* that a *Diamond* does; which is, as about $2\frac{1}{4}$ to 1.

LIV. Upon the River *Done* near *Aberdeen*, a little below the Bridge near the River's Mouth, there is a Bank, the Face of which is broken down, and it is full of *Stones*, which one would think were *in fieri*; they are all either round or oval, of different Sizes; the Faces of most of them are broken off, they are soft, and will easily rub down with your Hand, they are of different Grits and Colours, and are made up of different Sands and Clays mingled together: the Clay is soft both to Hand and Taste, in some of them white, in others gray, tho' in some Places the Clay and Sand are harden'd to the Consistence and Colour of such oval *Stones* as we usually see in the Fields; but where they are at the softest, the Bed that each *Stone* lies in, is always hard, and of another Grit and Colour.

Imperfect Stone in Scotland, by Dr. Geo. Gordon. n. 175. p. 1157.

LV. There is an excellent *Quarry* within Cannon-shot of *Maestricht*, lying in a Hill, where there are about 25 Fathom of Rock and Earth over head; it hath one Entry towards the River *Maese*, where Carts can pass with great ease, and unload the *Stones* upon the brink of the River; the *Quarry* within being parallel to the Horizon, and elevated but very little above the River. It affords one of the most surprizing Prospects, when well lighted with many Torches, that one can imagine. For there are thousands of square Pillars in large level Walks, and those almost every where above 20, and in some places many more Foot high; and all wrought with much Neatness and Regularity.

A Stone Quarry near Maestricht. by n. 67. p. 2051.

This *Quarry* serveth the People that live thereabout, for a kind of impregnable Retreat, when Armies march that way. For being acquainted with all the Ways in it, they carry into it whatsoever they would have safe as well their Horses and Cattle, as their movable Furniture, till the Danger be over; there being so vast a deal of Room, that 40000 People may shelter themselves in it.

In this vast *Grotto* 'tis remarkable, that there is but little Rubbishi, which shews both the Goodness of the *Stone*, and the Carefulness of the *Workmen*. And in divers places there are little *Pools* of *Water*, perhaps made on purpose for Beasts to drink, and to serve for other uses in time of need: For in no place almost are there any Droppings to be seen; nor are the Walks at all wet under foot: only it seems, that Rain gets in by the Air-Shafts, which for saving of Labour, and perhaps too, to make these *Pools*, are let down from

from such Places commonly, as are the *Pools* thereabout ; and so the Rain, that falls on the higher Grounds, does easily find the way thither.

*Quarries
and Rocks in
Austria and
Hungaria,
&c. by Dr.
Ed. Brown.
n. 59. p. 1050.*

LVI. Upon the North-side of Mount *Calenberg*, two *German Miles* from *Vienna*, are Stones mark'd with Trees and Leaves. In the *Hermitage* of the *Camaldulenses*, seated upon a Peak of this Hill, I saw fair ones, with which they paved the Walks in their Gardens.

Not far from *Manners Dorf*, is the Emperor's Quarry of Stone, out of which are made the best Buildings in *Vienna*: In which, wheresoever there is a Cleft or Separation of one Stone from another, the Water falling betwixt them, leaves a Petrefication ; thereby, as 'twere, healing the Wound, by making a stony *Callus*, not exactly like the Parts which it joins together.

An *English Mile* from *Freistat* in *Hungary*, Northward, is a Quarry of Stone, out of which many great Stones are digged, transparent and resembling *Sugarcandy*.

At *Banca*, two *Hungarian Miles* from *Freistat*, Northward, is a Quarry of *White Stone*, nigh the *Hot Baths* of that Place, over which is a Lay of *Chalk*, of about a Yard thick, very beautiful to the Eye, as being of all Colours except Green, so finely mixt, streaked and shaded, that it surpasseth *Marble Paper* ; and the Water dropping upon it, doth, as 'twere, varnish it.

At *Schemnitz* in *Hungary*, famous for *Silver-Mines*, is an high Perpendicular Rock, part of which, from the Top to the Bottom, is naturally tintured with a shining fair blue and green : And I have heard from a *Spaniard*, who lived long in the *West-Indies*, that there is also a Rock like this nigh to the *Silver-Mines* in *Peru*.

The Mountain of *Cliffura*, being a part of Mount *Hemus*, as also Mount *Pyrlipe*, do shine like Silver, and Day and Night, either by the Light of the Sun or Moon, afford a glittering pleasant Shew, caused by the great Quantity of *Muscovy Glasse*, wherewith these Hills abound. There are also *Talcum Rocks* nigh *Spital* in upper *Carinthia* : And a Hill nigh *Sarvizza*, which consists of an Earth of a fine red Colour, out of which the red earthen Vessels of that Country are made.

*White Marble in Ireland,
by Dr. Ash,
Bishop of
Cloyne. n.
243. p. 294.*

LVII. A Quarry of *White Marble*, is lately discovered in the County of *Antrim*, and 'tis of an extremely fine Grain, soft at first, but grows very hard afterwards, like *Portland Stone*.

*Stones growing at the end
of a Rush,
by Sir R.
Redding. n.
198. p. 663.*

LVIII. I send you herewith some Stones of an *Amber Colour*, taken out of a Spring, called *Cranbourn Spring* near *Lough Neah*, which the Country People tell us, grow at the end of a little Rush, and drop off, and are to be found only on a *Mayday Eve*, and good for God knows what : They look like the Germinations of some of your Salts, but in the Fire shew no signs thereof by Crackling : They are Electrical and Angular, and being pounded, the Powder is white.

LIX. I send

LIX. 1. The highest *Icy Mountains* of *Helvetia*, about *Valesia* and *Augusta*, in the Canton of *Bern*, about *Taminium* and *Tavetsch*, of the *Rhetians*, are always seen covered with Snow. The Snow melted by the Heat of the Summer, other Snow being fallen within a little while after, is hardened into Ice, which by little and little, in a long Tract of Time depurating it self, turns into a stone, not yielding in Hardness and Clearness to Chrystal. Such Stones closely joined and compacted together, compose a whole Mountain, and that a very firm one; tho' in Summer-time the Country People have observed it to burst asunder with great Cracking, Thunder like. Such Cracks and Openings being by the Wind covered with Snow, are the Death of those that pass over them.

The Icy Mountain Gletscher, by M. Muraltus. n. 49. p. 92. By --- to Mr. Justel. n. 100. p. 982.

At the foot of these Mountains, are with great Labour digged out Chrystals, which are found among other Fossiles, of two Sorts and Colours; some of them are darkish and troubled, which by some are called the *Chrystal Ore*, to be plenteously found in the Ascent of Mount *Gotthard*; others transparent, very pure, and as clear as *Venice Glass*, sexangular both great and small; as in the Mountains about *Valesia*, and the Town call'd *Urselen*, at the foot of the Hill *Sihelenin*, they are digged out, and sold at a good Rate; one particularly sold for 80 *l. Sterl.*

2. This *Icy Mountain* called the *Gletscher*, is very high, and extends it self every Year more and more over the neighbouring Meadows, by Increments that make a great Noise and Cracking. There are great Holes and Caverns which are made when the Ice bursts; which happens at all Times, but especially in the *Dog-days*. Very little of the Surface melts in the Summer, and all freezeth again in the Night. When the Sun shineth, there is seen such a variety of Colours, as in a Prism.

At the foot of the Mountain, a Rivulet issues forth from under the Ice, which is pretty deep and extremely cold.

There is such another Mountain near *Geneva*, and upon the *Alps*. A certain *Capuchin* told me, he had been upon the highest of these Mountains, with a Trader in Chrystal, who having driven his Hammer into one of these Rocks, and found it hollow and resonant, made a Hole in it, and thence drew forth a Substance like Talk; which to him was a sign there was Chrystal. After which he made a great Hole with Gunpowder, and found Rock Chrystal in it.

LX. Being in the *Val Sabbia*, at a Place called *Le Mezzane*, where I knew that Chrystals are generated, I observ'd in a spacious Round of a Meadow seated on a Hillock, some narrow Places bare of all Herbs, in which alone, and nowhere else thereabout, Chrystals are produced, being all sexangular, both points of them terminating in a Pyramidal Figure, sexangular, likewise.

The Formation of Chrystals, By P. Francisco Lana, n. 83. p. 4068.

I was told, that they were produced from the *Dews*, because (forsooth) being gathered over Night, the next Morning there would be found others at such a time only, when it was a serene and dewy Sky. But when I had examin'd that in the neighbourhood of that Hill, there was no Mark at all of any Mines, I did conclude that it might be a plenty of Nitrous Streams, which

might withall hinder Vegetation in those Places, and coagulate the Dew falling thereon; for *Nitre* is not only the natural Coagulum of Water, as is manifest in artificial *Glaciations*, but also it ever retains the abovesaid *sexangular* Figure, altogether like that of these Chrystals. Which may also be the very Cause of the *sexangular* Figure in Snow; this being nothing else but Water concreted by its natural Coagulum, which is a nitrous Exhalation. And to make it yet more manifest, that these are indeed Expirations of *Nitre*, I digg'd up some of the Earth, and drew a Salt from it, which had both the Taste and Figure of *Nitre*; tho' some Grains of it were of a square, others of a pyramidal Figure. And since these Chrystals are only found in those narrow Places, we may very probably infer, that from thence are raised the Exhalations, which do concrete the Dew; after such a manner as the Vapour or Exhalation of *Lead* coagulates *Quicksilver*.

An odd Fi-
gured Iris;
by Dr. Lister.
ter. n. 110.
p. 222.

LXI. I have not observed any Rock, or sort of Stone, whether metalline or more vulgar, which has not its different sort of Sparr both for Colour and Figure, which is very common in our blue Lime-stone Rocks in *Yorkshire*, out of which plenty of Lead-Ore is got. They are mostly of a black Water, like the black Flint in *Chalk Hills*, but there are of them, which have a purplish or *Amethystine* Colour, and some there are as clear as Chrystal. They adhere to the Seams of the Rock, be it betwixt Bed and Bed, or wherever there are cross and oblique Veins thro' the very substance of the Bed. The smaller the Veins, the less the *Iris*. You will find of them as small as Wheat Corns, and others an hundred times bigger. They shoot from both sides the Steam, and mutually receive one the other.

They are figured thus, viz. a Column of 6 Plains, very unequal as to the Breadth: the end adhering to the Rock is always rugged, as a thing broken off, the other end of the Column consists of three quinquangular Plains, very little raised in the middle: These Plains too are very unequal. Let them hug one another, and be any ways streightned and compressed in their shooting; yet the Number of Plains mentioned, both of the Column and Top, is most certain. The Places where infinite of them may be had, are *Rainborough* *Star* upon the *Ribble*, also in a Stone Quarry, near *Eshton* *Tarne* in *Craven*.

Transparent
Pebbles; By
Dr. Lister. n.
201. p. 778.

LXII. These transparent Stones are of a constant Shape, and in some ancient Leases of Royal Mines, they are called *rough* or *mineral Pearl*, being resplendent and bright, and figured like a Drop of Water. Some of them are exactly spherical, others like a half Globe, others like a half Oval, with an Edge raised on the top. It was not without reason that they were esteem'd by the Ancients; For their natural Polish is not to be counterfeited, but very easy to be distinguish'd with a Microscope, from the artificial Polish of Glass and Chrystals. Now Gold, Silver, Diamonds, Pearl, are for no other reason estimable, but because they have certain indelible Characters, which all the Subtilty and Wit of Man hath not yet been able to counterfeit, notwithstanding many pretences thereunto: as Gold, for example, that it will endure the drown-
ing

ing in *Antimony*; *Silver*, that it abides the Test of *Lead*; *Diamonds*, for that of themselves, even without a Foil, they cast a Lustre; *Peart* is valued because of its Figures, and peculiar Brightness not to be imitated.

These Stones are of the *Pebble Kind*, that is, not to be calcined by simple Fire, whereas most other figured Stones are calcinable with a very easy Fire. They are very hard and solid, and do not consist within of *Laminae*, or Flakes, but break every way with great difficulty, and naturally throughout smooth.

Their Figure comes nearest to that of the *Ombria*, and many of them are very *Ombria* in Shape. Other transparent *Ombria* I have seen, which yet are either very *Fliints*, or of a flaky and soft Contexture, of the Nature of *Selenites*; and such are to be found about *Filo-Briggs*, a noted Set of Rocks near *Scarborough*.

As these Stones are of a very different Nature and Texture from all other *Ombria* I ever yet saw, and having no *Vestigia* of any *Spine* in any part of them, I may reasonably enough conclude them to be Stones of their own Kind.

I am not averse to think, after so manifest and considerable Discoveries as *Augustino Scilla* hath made in *Sicily*, that most of the *Ombria* have been *Echini*, and yet some of the Prickled, which Naturalists have hitherto call'd *Lapides Judaici*, may have belonged to some of those *Ombria*. But there are only 2 or 3 *Echini* yet discover'd, either in ours, or the *Mediterranean Sea*; whereas of the *Ombria* of *Europe*, besides these present *Anomalous* Stones, there are at least 20 Species figur'd and describ'd by *Aldrovandus*, *Augustino Scilla*, *Dr. Plot*, &c. and in vast Quantities in most Counties of *England*: and I doubt not many more Species will yet be found out. All which are to be accounted for, as to the natural Places, in what Seas they are to be found at this day. And if not in the *European*, as I think they will not, how and whence they came hither into this Island in such plenty.

LXIII. 1. Among the excellent *Diamonds* brought from the *East-Indies* by *M. Tavernier*, there is one weighing $112\frac{1}{2}$ Carats, of a very fine Violet Colour, and two of a Rose pale Colour; all three of an *Adamantine Hardness*, and upon that account esteemed *Diamonds*.

Diamonds
By ---n.
102. p. 26.

2. The Parts of the World known to contain *Diamonds*, are the Island *Borneo*, and the Continent of *India extra & intra Gangem*: *Pegu* is likewise reported to have several, but the King contents himself with his Mines of *Rubies*, *Sapphires*, *Topasses*, *Emeralds*, *Gold*, *Silver*, *Brass*, *Tin* and *Lead*.

By the Earl
Marshal of
England, n.
136. p. 907.

The *Diamond Mines* on the Coast of *Coromandel*, (of which I have visited several) are generally adjacent to rocky Hills, or Mountains, whereof begins a great Ledge or Range, near *Cape Comorin*, extending in Breadth about 50 *Englsh Miles*, some conjoining, others scatter'd; and running thence in Length quite through *Bengala*. In, among, and near these Hills, in several Places, are known to be (as it is believed most of them have) Mines.

The Kingdoms of *Golconda* and *Vijapore*, contain in them Scope enough of Ground, known to have *Mines*, sufficient to furnish all the World plentifully with *Diamonds*; but their *Kings* permit digging only in some Places appointed, lest, as it is imagined, they should become too common; and withal for fear of tempting the threatening Greatness of *Aurenge Zebe*, forbidding also those Places that afford the largest Stones, or else keeping Workmen in them for their own private Uses.

1. In the Kingdom of *Golconda* (as near as I can gather from the best acquainted) are 23 Mines now employed, or that have been so lately.

Quolure was the first Mine made use of in this Kingdom: The Earth is somewhat yellowish, not unlike the Colour of our Gravel dried; but wetter in some places where it abounds with smooth *Pebbles*, much like those that come out of some of our *Gravel Pits* in *England*. They use to find great Quantities in the Vein, if it may properly be so call'd, the *Diamonds* not lying in continued Clusters, as some imagine, but frequently so very scattering, that sometimes in the Space of $\frac{1}{4}$ of an Acre of Ground, digg'd between two or three Fathoms deep, there hath been nothing found; especially in the Mines that afford great Stones, lying near the Superficies of the Earth, and about three Fathoms deep. The *Diamonds* found in these *Mines* are generally well shaped, many of them pointed, and of a good lively white Water; but it also produces some yellow ones, some brown, and of other Colours. They are of ordinary Sizes, from about 6 in a *Mangelin**, (of which they find but few) to 5 or 6 *Mangelins* each; some of 10, 15, 20, they find but rarely. They have frequently a bright and transparent Skin, inclining to a greenish Colour, tho the Heart of the Stone be purely white; but the Veins of these Mines are almost worn out.

* A *Mangelin* is 4 Grains in weight, saith *Lin-schotten*.

2. The Mines of *Codawilikul*, *Malabar* and *Buttepallem*, consist of a reddish Earth, inclining to an Orange Colour, (with which it stains the Clothes of the Labourers that work in it;) they dig about 4 Fathoms deep. They afford Stones generally of an excellent Water, and chrystalline Skin: smaller Sizes than those of *Quolure*, *Ramiab*, *Gurem*, and *Muttampelle*, have a yellowish Earth like *Quolure*; their Stones like those of the two former Mines, but mixed with many of blue Water. These 5 Mines being under the same Government with *Melwillee*, where the Governour resides; he has lately forbid their Use, and commanded all to repair to his Residence.

Curru (the most famous of them all, and most ancient) has been under Subjection of the King of *Golconda*; but about 25 Years ago was taken, with the Country of *Karnaticum*, from the *Hundue-Rajaes*, by the *Nabob Meer Jumla*. In it have been found *Diamonds* of a *Seize Weight*, which is about 9 Ounces *Troy*, or 8 $\frac{1}{2}$ *Pago's* Weight. It is only employed by the King for his own private Use. The *Diamonds* that are found in it, are very well spread, large Stones (it yields few or none small) they have generally a bright Skin, which inclines to a pale greenish Colour, but within they are purely white. The Soil is reddish, as many of the others.

About

About 60 or 70 Years ago, a *Portuguese* went thither from *Goa*, and having spent in Mining all that he had, even to what wearing Clothes he could spare, while the Miners were at work for the last Day's Expence, he had prepared a Cup of Poison, resolving if that Night he found nothing, to drink his last with the Conclusion of his Money; but in the Evening the Workmen brought him a very fair spread Stone, of 20 *Pago's* weight, in Commemoration whereof he caused a great Stone to be erected in the Place, with an Inscription engraven on it, in the *Hindues*, or *Tellinga Tongue*, to the following effect, which remains to be seen till this day :

*Your Wife and Children sell, sell what you have,
Spare not your Clothes, nay, make your self a Slave :
But Money get ; then to Currure make haste,
There search the Mines, a Prize you'll find at last.*

Not far from *Currure* are the Mines of *Lattawaar* and *Ganjeconta*, which are in the same Soil as *Currure*, and afford Stones not unlike : But *Lattawaar* hath many representing the great End of a Razor Blade, thin on one side, and thick on the other, very white and of an excellent Water ; but the best of the Mine is worn out, and *Ganjeconta* employed only to the King's private Use.

Jonagerre, *Pirai*, *Dugulle*, *Purwillee* and *Anumapelle*, consisting also of red Earth, are now employed, and afford many large Stones, part of them of a greenish Water : but the most absolute Mines are of *Wazzengerre*, and *Munnemurg*, (the other rather representing Pits than Mines) for there they sink thro high Rocks, till they go so far below their Basis, that they can go no further for Water, in some places 40 or 50 Fathoms deep. The Superficies of the Rocks consists of hard, firm, white Stone, into which they cut a Pit like a Well, of about 4 or 5, in some places 6 Foot deep, before they come to the Crust of a *Mineral Stone*, like the *Mineral* of *Iron* ; then they fill the Hole with Wood, and keep as hot a Fire as they can there for 2 or 3 Days, till they think it sufficiently heated ; then they pour in Water till they have quenched it, which also flakes and mollifies both Stone and *Mineral* : both being cold, they dig again, take out all the crumbled Stuff, and dig up what they can besides, before they heat it anew. The Crust seldom is thicker than 3 or 4 Foot, which ceasing, they come to a Vein of Earth, that usually runs under the Rock 2 or 3 Furlongs, sometimes much further. This they dig all out and search, and if their first Attempt prove successful, they go to work again, digging again after the same manner, as deep as they can, till they come to Water ; for the drawing whereof, wanting the Help of Engines known in *Europe*, they can go no deeper, altho the Veins lie lower : all Lumps of the *Mineral* they break in pieces, and frequently find Diamonds inclosed in them. The Earth is red, many large Stones are found here, the smallest about 6 in a *Mangelin*. They are mixed Waters, but the greatest part good, only of ill-favour'd Shapes ; many cragged Pieces of Stones, some as if they had been Parts of very great ones ; others with Pieces

bro-

broken off them ; yet I never heard of any that found two seeming fellows, altho' they do those that look as if they had been newly broken.

In *Langumbot* they dig as they do at *Wazzergerre* and *Munnenmurg*, the Rock is not altogether so solid, but the Earth and Stones it produces much alike.

Wootoor lies near *Currure*, and affords Stones of a like Magnitude, Shape and Waters ; 'tis employed only to the King's use : and singular, in that its Diamonds are found in black Earth.

Muddemurg far exceeds all the rest for *Diamonds* of a delicate Shape, Water, and bright transparent Skin ; yet it has store of veiny ones, but those likewise of so curious Shape and Water, that it is difficult to discover them from the good, especially the small ones. It produces *Stones* of divers Magnitudes, from 10 and 12 in a *Mangelin*, to 6 or 7 *Mangelins* each ; and besides, some great ones. The Earth is red : but it is seated in the Woods, and the Water so bad, that to all (except the People bred there) it presently occasions Fevers, and destroys abundance, insomuch that most of the *Adventurers* have forsaken it ; notwithstanding which, it had been more profitable than any of the rest, the Vein frequently lying near the Superficies of the Earth, seldom running deep, and is better furnished than any one yet discovered. The River *Kishma*, of excellent Waters, is but 9 Miles distant, but the Miners or Merchants will not be at the charge of fetching their Water from thence. Divers are of the opinion, that besides the Water, the Town lying in a Bottom, environ'd with Hills, and a Morass adjoining, the Air may be infected, and contribute to its Unhealthfulness.

Melwillee, or the new Mine, so call'd, because it was but lately found out, or at least permitted to be made use of, in the Year 1670 ; it had then a Year employed the Miners, but it was forbidden, and lay unoccupied till 1673, when Complaints being made at *Quolure*, that the Vein was worn out, the King again licensed its settlement. The Earth they mine in is very red, and many of the *Stones* found there, have of it sticking to them as if it had clung there while they were of a soft glutinous Substance, and had not attained their Hardness, maintaining its Colour on its Skin (seeming to be roughned with it) that it cannot be fetch'd out by grinding on a rough Stone with Sand, which they make use of to clean them. The *Stones* are generally well shaped, their size from 5 or 6 in a *Mangelin* to those of 14 or 15 each, and of some bigger ; but greatest Quantities of the middle sorts : Most of them have a thick dull Skin, incline to a yellowish Water, not altogether so strong and lively as of the other Mines, very few of them of a chrystalline Water and Skin. They are reported to be apt to flaw in splitting, which occasions those People to esteem them something softer than the Product of many of the other Mines ; several that flatter by their seeming *Whiteness*, when rough, discover their Deceitfulness, having passed the Mill, and too often a yellowish Tincture, to the disappointment and loss of them that have cut them ; but what they want in Goodness is in part supplied by the plenty they find, which, together with their Properties, make them the cheaper.

2. *Vijapore* is known to contain Mines enclosing Stones as large and good as those of *Golconda*, but the King makes use but of the meanest. There are 15 Mines employed in this Kingdom.

In *Ramulconeta-Mines*, in red Earth, about 15 or 16 Foot deep; they seldom find a *Diamond* of a *Mangelin* Weight, but small, to 20 or 30 in a *Mangelin*. They are generally of an excellent *chrystaline Water*, have a bright clear Skin, inclining frequently to a pale greenish Colour, are well shaped, but few of them pointed ones. There are also found amongst them, several broken Pieces of *Diamonds*, by the Country People called *Shemboes*.

The Mines at *Banagunnapelle*, *Pendekul*, and *Moodawarum*; at *Cammerville*, *Paulkul* and *Workul*, which are not far distant from *Ramulconeta*, afford Stones much alike, and in the same kind of Earth; but in the three last are very small ones, even to 100 in a *Mangelin*.

Lungepoleur Mines are of yellowish Earth, like those of *Quolure*; its *Diamonds* are generally well shaped, globular, few, pointed, a very good chrystaline Water, and bright Skins; many of them have a thick dark Grass-green Skin, some spotted also with black, that they seem all foul, yet are not so, but within purely white and clean. Their Sizes are from 2 or 3 *Mangelins* downwards, but few very small. *Pootloor-Mines* are of a reddish Earth, but afford Stones much like those of *Lungepoleur*, only smaller: under a *Mangelin*, the general Sizes are of $\frac{2}{3}$, $\frac{1}{2}$, $\frac{1}{3}$, $\frac{1}{4}$, of a *Mangelin*.

Punchelingul, *Shingarrampent*, and *Tondarpaar*, are also of red Earth, their *Diamonds* not unlike those of *Quolure*, only rarely or never any large ones are found there.

Gundepellee hath the same Earth with the former, and produces Stones of equal Magnitude; but frequently of a pure *chrystaline Water*, wherein they exceed the former.

Donee, and *Gazerpellee*, dig both in red Earth likewise, and afford Stones alike, the greatest Part whereof are of good Shapes and Waters. They have also many *Shemboes*, and some of bad Waters, some brown, which these People call soft, or *weak-water'd*, being esteem'd of a softer and weaker Body than others, by reason they have not so much Life when cut, and are subject to flaw in splitting, and on the Mill. Their general Product is in Stones of middle Sizes: But *Gazerpellee* has besides many large ones, and is the only Mine noted in the Kingdom of *Vijapore*.

The *Diamonds* (in all the Mines) are so scattered and dispersed in the Earth, and lie so thin, that in the most plentiful Mines it's rare to find one in digging, or till they have prepared the Stuff, and do search purposely for them. They are also frequently inclosed in Clods: and some of those of *Melwillee* have the Earth so fixed about them, that, till they grind them on a rough Stone with Sand, they cannot move it sufficiently to discover they are transparent; or, were it not for their Shapes, to know them from other Stones. Sometimes the unskilful Labourers, to try what they have found, lay them on a great Stone, and striking on them with another, to their costly Experience, discover they have broken a *Diamond*.

Near

Near the Place where they dig, they make a *Cistern* about 2 Foot high, and 6 Foot over, with a small Vent in one of the Sides, about 2 Inches from the Bottom, by which it empties itself into a little Pit made in the Earth to receive small Stones, if by chance any should run thro. The Vent being stopped, they fill the Cistern they have made with Water, soaking therein as much of the Earth they dig out of the Mines, as it can conveniently receive at a time; breaking the Clods, picking out the greatest Stones, and stirring it with Shovels till the Water is all muddy, the gravelly Stuff falling to the Bottom: then they open the Vent, letting out the foul Water, and supplying it with clean, till all the earthy Substance be washed away, and none but a gravelly remains at the Bottom. Thus they continue washing till about 10 of the Clock before Noon, when they take the gravelly Stuff they have washed, and spread it on a Place made plain and smooth like a Bowling-Alley, for the Purpose, near the Cistern; which being soon dry'd by the Heat of the Sun, at that time of the Day, they very curiously look it over, that the smallest Bit of a Stone can hardly escape them. If they find a large Stone, they deliver it not till they have done work; and then very privately, lest it should come to the Knowledge of the Governour of the Place, and he require a Share, which in the Kingdom of *Golconda* is usually practised, without respect to any Agreement made with them.

The Miners, those that employ them, and the Merchants that buy the Stones of them, are generall *Ethnicks*; not a *Mussulman*, that ever I heard of, followed the Employment. These Labourers and their Employers are *Tel-linga's*, commonly Natives of or near the Place. The Merchants are the *Banians* of *Guzzarat*, who, for some Generations, have forsaken their own Country to take up the Trade, in which they have had such Success, that 'tis now solely engrossed by them; who corresponding with their Countrymen in *Surat*, *Goa*, *Golconda*, *Visiapore*, *Agra* and *Dillee*, and other Places in *India*, furnish them all with Diamonds.

The Governours of the Mines are also Idolaters. In the King of *Golconda's* Dominions, a *Feulinga Bramme* rents most of them, whose Agreement with the Adventurer is, that all the Stones they find under a * *Pagoda* Weight, are to be their own, all of that Weight and above it, to be his for the King's Use. Both Merchant and Miner go generally naked, only a poor Clout about their Middle, and a Shash on their Heads; they dare not wear a Coat, lest the Governour say they have thriven much, are rich, and so enlarge his Demands on them. The wisest, when they find a great Stone, conceal it till they have an opportunity, and then with Wife and Children run all away into the *Visiapore* Country, where they are secure and well used; by reason whereof, their Mines are much more populous, and better employed than those of *Golconda*.

It is observable, that notwithstanding the Agreement with the Adventurers of the Mines, that all Stones above a certain Weight shall be for the King's Use; yet in the Metropolis of either Kingdom, as the Cities of *Golconda* and *Visiapore* are, there is no Seizure, all Stones are free: and the late deceased King, *Abdub Cutopshaw* of the former, and *Edelsbaw* of the latter, would
not

* A *Pagoda's* Weight is 9 Mangelins.

not only give very great Prices for large Stones, but richly vest, and present the Merchant that sold them, with Horses, or something else of Value, thereby encouraging others to bring the like.

LXIV. 1. Mr. John Schefferus conceives Amber to be a kind of Fossile Pitch, whose Veins lie at the bottom of the Sea; believing that it is hardened in tract of Time, and by the motion of the Sea cast on Shore. He adds, that hitherto it hath been believed, not to be found but in *Borussia*: But he assures that it is also found in *Sweden*, on the Shores of the Isle of *Biorkoo*, in the Lake *Melero*, whose Water is sweet. Of this he saith, he hath a fine piece by him, two Inches large and thick, presented him by one, that himself with his own Hands had gathered it, and several other Pieces, on the Shore of the said Island; affirming withall from the mouth of a Shepherd of that place, that it is thrown out by a strong Wind, bearing upon the Shore.

Tb: Production of Amber; By Mr. John Schefferus. n. 19. p. 349.

2. I am almost of the same Mind with Mr. Schefferus, that Amber is a kind of Fossile Pitch, or *Bitumen*, seeing it is not only found on the Shore of the *Borussian* Sea, but also digged up in subterraneous Places, some German Miles distant from the Sea; and that not only in Sandy, but also in other Hills of firmer Earth; of which I have seen my self pretty big Pieces.

By Mr. Hevelius. ib. p. 346.

3. *Succini Antiquissimis Temporibus cognita Virtus celebre ipsi, pluribus ante Christum natum seculis, apud scriptores Græcos peperit Nomen. Postquam Romanis Admirationi esse cœpit, & his Auctoribus Gemma reddita est Memorabilis: Præsertim cum Neronis Mores in Luxum Succino abuti docerent. Quantacunque vero Succinorum vetusto Ævo fuerit Æstimatio, Terræ tamen, in quibus generantur, incognitæ mansere; inde tot sententiarum Divortia; his in Africa, istis in Asia, aliis in Europa, Thesaurum reconditum memorantibus. Inter Europæas Ditiones, Italia, & in eadem Eridani vicinique Maris Adriatici ex succineis Divitiis præcipua Laus fuit; quam tamen fida magis Historia, Romanis latè per Germaniam Victricia Arma circumferentibus, Maris Germanici ac Baltici Insulis vendicat, Hispania & Britannia in partem aliquam Gloriæ admittis.*

An Account of Amber, By M. Phil. Jac. Hartman. n. 248. p. 5.

Verum ut Veteribus tot Regiones *Succiniferas* allegantibus ignosci posset, nescio an proximo aut huic nostro Ævo Venia sit danda, etiamnum ex *Africa* & *Asia*, quin ex novo detecto Orbe, nativum Succinum afferenti, vulgato insuper *Orientalium Succinorum* Nomine. Quod enim cum Pace tantorum Virorum dixero, plerique Auctorum sunt intestabiles, Rumoribus plus justo tribuentes; Oculatos Testes, fallere & falli nescios, vix produxeris. Per multos quidem qui in *Orientalibus* Partibus commorati diutius, Rerumque Physicarum fuerint gnari, ipsemet atque Amici, coram & Literis, percontati sumus, neque incidimus in quempiam, qui certi quidpiam cum Fiducia edisserere noscet; majorque pars, quicquid de *Orientali Succino* Fama sparsit, aut scriptis prodidit, Incertitudinis aut Falsitatis condemnavit. Quin Nomen *Ambari* sive *Ambra*, quod Succino cum Pretiosissimo & Fragrantissimo *Orientali Bitumine* jamdiu apud plurimas Nationes commune esse cœpit, non paucos in Errorem induxit: *Succinum* enim crediderunt, quum *Ambra* in *Africa*, *Asia*, *Americave* Partibus nasci acceperant. Si non alius

Error *Succinum Orientale* progenuit, *Refina Copal*, *Succinum* mentiri aptissima, hoc Nomine ab *Officinis Pharmaceuticis* adopata.

Nec in *Europæ* memoratis omnibus Provinciis *Succinum* generatur; in-
nibus Auctorum de *Eridano*, *Mari Adriatico*, aliisque *Italiae* locis *Succiniferis*,
Commentis. Nec de *Hispano*, *Britannico*, *Pannonico Succino* graviora aut cer-
tiora prostant Documenta *Gagates Succini Nigri* Appellatione scriptoribus im-
posuisse videtur. De *Polonicis*, *Silesiacis*, *Bohemicis Succinis* effossis, quamvis
raros in Patriis Annalibus præcones nacta sint, indubitata Experientia con-
stat. *Germanici* *Succini* crebrior & evidentior est Memoria. In Litoribus
Maris ad Insulas *Belgicas*, ad *Holsatiam Jutiam*, in Ripis etiam Fluviorum,
lectum; quin ex interioribus Terræ visceribus erutum, gravissimi Auctores
consignarunt. *Saxonia*, *Misnia*, *Islebia*, *Suevia*, ex Gremio Matris Telluris se
hunc Fætum suscepisse, aliquoties attestantur: *Hallensesque* Carbonariæ Fo-
dinæ, serenissimi *Frederici III.* Auspiciis non ita pridem detectæ, succineas
viliores Glebas plus via simplici ostenderunt; Fidem faciente *D. Krug*, *S.*
Electoris Brandenb. Archiatrorum Comite & Consiliario, Rerumque Me-
tallarum Directore gnarissimo atque meritissimo. Nec Ignobilia Testi-
monia inclyta *Marchia* perhibet: Superiori seculo *Jodochus Wilichius*,
prope *Neomandram*, novam Collam dictam, *Francofurto* ad *Oderam* tria
Milliaria circiter distantem, in Lacus ingentis Ripa *Succinum Falernum*
reperit; Nostra Ætate in ripa *Viadri* prope *Custrinum* juxta Pagum *Schaum-
berg* inventum, *Cl. D. Becmannus*; æque Fossa Insulæ *Pottamensis* regnante
Magno *Friderico Wilhelmo* eductum, *Cl. D. Elsboltius*, memorarunt. Major
autem *Succinorum* est proventus in locis *Mari Baltico* vicinis. *Suecia*, vel
ex Lacus dulcis *Meleri* Ripa ejectum, sæpius legit, aut effossum fustulit;
Dania ex Fossa *Hafniensi* insignia *Succina* vidit, & admirata est, atque ex
Collibus *Selandiæ* suæ *Mediterraneis* non contemnenda Magnitudine ac
Multitudine prodiisse, uniusque Colliculi Fossionem quinquaginta Libras
erogasse, vomereque ex Agris extracta, meminit; Testesque *Cl. Borrichii*
adsunt Literæ, insulas *Cimbriam Holsatiamque* allambentes [*Formoe Mandoe*,
Rom.] ad Litora sua in Oceano pariter copiosum *Succinum* expiscari. Li-
beralius tamen longe in *Samogitiæ*, *Curoniæ* & *Livoniæ* Contermina Maris
Baltici Litora *Succineæ* Opes redundant; ut inter *Algas Arenasque* abscon-
ditæ à Rusticis confertim deprehendantur. Inter *Arandum* quoque, & inter
Fodiendum, in *Maritimis Jugeribus* sese ultro, sine gravioris Laboris impen-
dio, offerunt, vili Pretio ab *Electrotoreutis* ibi locorum quondam coempta.

Verum nulla *Maritimarum* Provinciarum, æque opima spolia ex *Mari*
Baltico legit, nulla ex sinu Telluris æque numerosam Prolem *Succineam* sus-
cipit, ac *Prussia*; ut *Electrides Antiquorum* nullibi rectius collocaveris. Al-
lata sunt mihi ex *Sambia*, ex *Natangia*, ex *Hockerlandia*, ex *Pomerania* for-
tuito inventa *Succina*; & prope Opida *Hollandiam*, *Liebstadium*, detecta;
quæque ex *Electoralis Lithuanæ* Agris effossa, *Varmiensi* quoque & *Elbin-
gensia* possideo. Olim Vir Consularis, mihi Amicissimus, annotarat, in Sylva
quadam *Kerbswald Elbingensis* Ditionis An. 1641. intra modicum Temporis
spatium, Septingentas Libras fodiendo ex Terra erutas; frustumque insigne
Amicus nuperrime dono dedit, cujus idem Natale fuerat Solum. Et in Ri-
pis Lacus recentis ac *Curoniensis* Fluviorumque *Pregelæ*, *Vistulæ*, *Elmæ*,
lecta.

lecta adeptus sum. Adeoque nullus dubito, totum Prussiae Fundum Succineum affirmare, praesertim cum scaturigo de repente An. 1666. circa Oppidum *Bartenstein* exundans, tantum vim Succinorum egresserit, ut Fisci Reditus augetet; quæ a Terræ visceribus avulsa, nec Mare vidisse unquam, certa est Fides.

Post *Prussiam*, *Pomerania Succinifera* nominari meretur, illo potissimum Orae Maritimæ Tractu, qui per littora Electoralium hinc & Olivensum ac Gedanensium Ditionum ad Neriam Recentem excurrit. Multum Succini cum Decumanis Fluctibus ad hanc Oram advolvitur, iisdem signis proventum manifestantibus Electrotoreutarum Gedanensium Quæstu non spernendo, quia senatu justo prætio, quæcunque ad Neriam appellant, redimerunt. Ad Insulam Rugiam usque Maris Baltici effusa est Liberalitas, siquidem & hæc Succineis Glebis potitur; juxta *Hiddensee* & lectas & haustas percepi. Nec Mediterranea Pomeraniæ Succinorum sunt vacua, quippe quod pariter bona Fortuna in eadem Ruricolæ aliud agentes incidant sæpius; *Curoniaeque* & *Samogitiæ* inter *Succiniferas* Palmam *Pomerania* dubiam reddit.

Prussiam quaquaversum *Succiniferam* prædicavi, ut tamen præcipue Littoris *Sudavici* amore *Succina* detineantur; situm est Littus in ista parte, quæ *Sambia* vocatur, a novo Transitu (*Neve Tiff*) ad Tabernam (*Vrantz Vrug*) decem Milliarium spatio. Regia hæc Succinorum sedes, septem Recessibus vulgato Angulorum vocabulo, antiquitus distinguitur: *Krecke*, *Nodums* vel *Nodems*, *Lassnicken*, *Kuckse*, sive *Kuyck Palmenick*, *Nempe*, *Thierskeim*; Nostra Ætate non *Nempe*, sed *Kraydepellen*, sive *Crapellen* inter *Palmenig* & *Subenig*, tum *Bruster* magis quam *Dirschkeim*, & præter hos alii accensentur. Littus omne altis Montibus præcingitur, Mari Vadoso; a primo ingressu Trium Quatuorve, mox Triginta, aut Quadraginta Orygarum, postquam progressus fueris Profunditate minori, pergendo longius rursus altissima; ut *Brevia* sive *Syrtes* intelligas, quæ Littus *Sudavicum*, hujusque Recessum *Brusteram* adprime Naufragiis infamant. Prærupta & ardua Recessum *Juga*, quædam lentius attolluntur, versus *Pillaviam* in Planitiem desinunt. Solum minus firmum; alicubi latentium Aquarum commeata fallax, in tantum ut quasi Voragine Equi & Homines absorpti memorentur; maximam partem Sabulo tegitur, aliquot *Areolæ* Herbis investiantur, *Petasite*, *Eryngio*, *Lappa*; raris Arbustis aut Senticetis, quæ tamen ad *Brusteram* silvescunt; eademque cum parte Montis aliquando subfidunt, Rupes nullæ nec Saxa, præterquam ad Radices Montium: Aquæ ex summis jugis passim dimanant, quæ inferius Alveis collectæ Rivulos imitantur. Ista exteriori facie Littoris *Sudavici*, interanea Mineralibus abundant: *Vitrioli* non una comparet species: Alibi niveis striis, Terra nigra interjecta, stratum super stratum alicubi Fusum Vitrum, Ligneis Fibris hinc inde interlucentibus, præsentat; alibi Terræ Micantium Pulvisculorum instar est admixtum. Præter *Vitriolum* Corticosa Terra, qua integri Colles exsurgunt, & Lignum quod Littoreos Montes longo tractu medios dividit, sunt conspicua; tum terra flavescent, quæ *Ochram* æmulatur, & lutum cæruleum, certis Intervallis per Littus expansum. Ex Lapidibus memorabiles *dactyli fidei* (*Alpenschofs*) inter Saxa & Arenas dispersi, sed & ex Montibus effodiuntur:

Saxa Mari vicina alia parte durissima, alia friabilia videntur: Petrefacta quoque Ligna Lapidesque *Alga Marina* tenui Folia & vesiculari luxuriantes inveni: Mitto varios lusus Naturæ in quos incidi. Præter vulgares Lapides, & *Adamantes*, & *Jaspides* hoc Littus quandoque profert. Camporum Vicinorum sterilitas summa; Silvæ raræ, Pineæ nullæ. Illud adjiciendum, quod *Phocarum* Greges apricantes, in Scopulis & Collibus vadosi Maris colludentes, sæpius se conspiciendos præbeant.

Littus hoc quidem inter Arenarum Lapidumve acervos *Succina* monstrat, sed in his non generari manifestum est: Multo minus ex *Alga Marina* natales accersendi, licet huic involuta ad Littus propellantur. Et quum intra Viscera Montium Littoreorum ubique reperiuntur, in *Vitrioli* interstratis *Chrysgallis*; in Terræ Flavæ, in Sabuli, in Luti Cærulei intertexto opere; non tamen in his omnibus prima eorum statuenda Incunabula. In *Vitriolorum*, Terræ Flavæ & Sabuli partibus raro eventu *Succina* eaque minuta & ignobilia deprehenduntur. Cærulei Luti ductus nondum ita Experientia patuere, quod inaccessi; quamvis Egregia & Numerosa *Succina* fovere a Colonis tradantur; mihi que diffracta Luti Gleba, Nativus Fœtus *Succineus* animadversus, quem tenui Cortice obductum, Colore fulvo dilucidum, inter cara Naturæ *Succinea* munuscula Musæum asservat.

Quum autem Corticosa Terra, & præter hanc Lignum *Litus Sudavicum* discriminant, Lignum quod Montes interfecat *Succiniferum* esse, ut quod maxime, multum Annorum Experientia firmat. Hujusque Ductum Fossiles indagant & observant, nunquam irritò Successu, quousque instabile solum ipsorum operas progredi permittit. Terra Corticosa *Succina* exigua complectitur: minusque solida, & ingrati Coloris. Lignum autem minime ab Arboribus est arcessendum; siquidem tam vastos Truncos Arboreos, qui prostrati plurimarum Orgyarum Longitudine & Latitudine Fibras suas extenderent, nusquam Orbis vidit. Neque Arboreis Lignis simile est: quippe, quod nec Medullæ Intimæ nec Corticis Extimi ullum præbat indicium; Ramorum quoque Divaricationibus ac Nodis, Foliorumque Germinibus, prorsus destituitur; neque Fibras mutat, sed easdem quavis sui parte retinet: mitto quod Compagem Ligneam referens non tamen orbiculatim concrevisse cernitur, sed planiori specie.

Atque Curiosi jamdiu Ligna *Subterranea* mirari desierunt, postquam plures *Europa* Ditiones istiusmodi, e Terra eruta, ipsorum Censuræ submiserunt. Ducatus *Spoletani* sive *Umbria* fodinarum Lignum elegantissimum undulatum, in quo & Artificum ingenia se exercere poterant, *Franciscus Stellutus Lynceus* descripsit, inventore Duce & Principe *S. Angeli Friderico Cesio*; ejusdem & *P. Kircherus* meminit. Aliud *Germania* Fossile Lignum, Solertia *D. Pillingen* in *Misnia* detexit, qui & erudito Commentario Generationem illustravit. Transmissus mihi *Lunenbergenfis* Ditionis Subterraneus Fœtus Ligneus, *Prussico* Solidior & Ponderosior. Lignum vero quale *Litus Sudavicum* profert, & alibi locorum, in *Prussia* Interiori, una cum *Succinis* erutum, ex complurium Amicorum Literis fide dignissimis rescivi: Gravesque mihi Auctores *Bartholinus* & *Borrichius*, qui Cortices & Ligna ex Fossis *Hafniensibus* iisdem, ex quibus *Succina*, non exigua Quantitate educta attestantur; felixque Capuræ indicium, in Litore *Neringæ* ex adnatantibus Fragmentis capitur.

Matricis

Matricis autem hujus, Experientia Duce, ista indagavi Initia ac Rudimenta. Colliculi in Litore *Sudavico* hinc inde, imprimis ad *Kraxteppelin*, procul Terra congesta, ubi propius accesseris Cumuli Coacervatorum Corticum videntur: Superior pars, sicubi a Sole exsiccata, fuit *Griseis*; his autem remotis, piceæ *Nigredinis*, magnis & levibus nitidisque Crustis concretam offert Terram, quam si Cultro secueris, multorum molissimorum Corticum Compagem conspicias; ad Radicem istorum Colliculorum Uda Terra, Glutinoso ac Tenaci Liquore cohærens, Manuum Digitorumque impressorum Vestigia exacte refert, sed ut & tangentes denigret. Talem Corticosam Pinguem Colliculorum Terram *Ligni Fossilis Prussici* judico Primordium; neque Lignum nisi Siccitate, & qualicumque Soliditate, qua magis compactum longiori Fibrarum Proensione, continua cohæret, a Corticibus istis differt. Corticosi enim Colliculi ab Uda Tenaci Terra nascendi Originem sortiuntur: Hanc postquam Maris Salsugo aliis *Subterraneis Salibus* admixta maceravit ac subegit, secedente Humore superfluo, Aer aut Calor Solis exsiccatur; Siccitate vero a se invicem secedunt partes, quarum Pinguedo exhalavit, aut intus concessit: aliæ quæ Glutine hoc abundant, mutuo, licet in Crustas compactæ, cohærent, Speciemque Ligni referunt ubi iusta Siccitas, qualicumque multarum Crustarum Cohæioni Lignosam Formam conciliavit. Bituminosam vero Corticum & Ligni esse Naturam non solum Terrestris Pinguedo, sed & Examen ignis monstrat; accensa enim Fomitis instar Serpentinum Ignem propagant, Sulphurque Naribus afflant; & Destillationi exposita, uti inferius tradituri sumus, aliquot Oleosas particulas, *Olei Petræ* simili Odore, dimittunt, præterquam quod Liqueor Destillans *Succineum* Pingue quid exhalet. Post Bitumen Corticum & Ligni Generationem Salia Subterranea promovent; ab his enim Siccitas, & Crustarum Species deducenda intime enim Lignis & Corticibus adhærent, *Vitriolum* superius dissecuimus, quomodo Cortices undique ambiat, atque cum illis concreascit. Aliorum Salium non ita manifesta est Demonstratio; Deprehendi tamen in siccissimorum Lignorum Corticosæ Compagis Interstitiis, scintillantes salinas Stellulas & Fila splendentia, quæ *Vitriolum* minime referebant, insipidæ enim prorsus, aut subdulces, lenissime adstringentes: Aqua affusa eduxi illas Stellulas, *Lixiviumque Aluminis* aut magis *Martis* subdulcem saporem prætulit, ut tamen *Vitriolica* Virtus extremum perciperetur, quæ inspissato *Lixivio* evidentior, aliquo tamen Subdulcis *Aluminosi* aut *Martialis* Saporis sensu. *Nitrum* quoque sub hoc Ligno latens olim detexi, Forti *Lixivio vitriolico* particulis segregatis; quamvis ipsi *Vitriolo Prussico Nitrum* videatur admixtum: forte & Stellulæ ac Fila salina per intimas Ligni Fibras diducta, *Nitrosa* sunt Naturæ. *Alumen* quoque in Crystallis *Vitrioli* latet, si non prorsus *Alumini* vindicandi, quos *SSS* componere asseruimus quique *Amianto* aut *Alumini Plumoso*, similes conspiciuntur: acidulus enim horum sapor, ad illum salis *Succini* volatilis proxime accedens.

Matrice cognita, quibus *Bituminis* & *Salis* Virtutibus sit impregnata facile est conjicere quomodo *Succineus* Fœtus *Prussicus* intra illam concipiatur. *Prussica* solum undiquaque *Bituminosum* cogita; insignes enim Glebæ *Bituminis* condensati in abditis Terræ aut Luti aliquoties a Colonis casu deprehensæ; ipse semet aliquot *Librarum* Frustum non procul a *Regiomonto* ex Limo eductum;

conspexi, quin *Olei* rivos ex Terra dimanasse, non vana Fama accepi. Cespites vero *Bituminosi* ex pluribus Locis effodiuntur. *Bituminoso* itaque Litoris *Sudarvici* Solo Calor Subterraneus, quicumque iste fuerit, *Bituminis* exhalationes per interranea dispersas, undique consociat, & in Guttas cogit, præprimis ex Corticosa aut Lignosa Matrice easdem congregat; quod dum agit, simul vicina *Salia* pervadit, ipsorumque Effluvia secum abducens *Bituminosis* Guttis immiscet; *Salina* spicula intra Matricem adaucta Fluorem *Bituminosum* sistunt, & si nullæ Suppetiæ *Bituminosarum* Guttarum a Calore submittuntur, Gleba pro Modulo incunabuli, quod intra *Lignum* ipsi concessum, formam subit, omnique Exhalationum motu sopito, Caloreque evanescent, *Salina* particulæ Rigorem recuperant, *Bituminosis* superfluum Humorem exhalantibus, sociatæq; *Succineam* Gemmam producunt; Nitidiorem, Splendidiorem, Fragrantio rem, Firmiorem, ex Puritate & Proportione exhalationum *Bituminosarum* ac *Salinarum*. Hæc vera *Succini* est Generatio, quam ante nos nemo Erudito Orbi perspicuam reddidit.

Aliquibus tamen is superest Scrupulus, an eadem *Succinorum* quæ Mare eiecit, Generatio statuenda? Verum cum in Vulgus hic locorum jam notum sit, ex Collibus Marinis Tempestatum vi disiectis aut convulsis *Succina* prodire, quæ a Fluctibus ad Litus advolvuntur, Capturæ fructuosæ aut inanis, ex Collium istorum Divulsione, leviori aut profundiori, sumpto Indicio; Qui, inquam, cùm Haustilia *Succina* intra Colles generari certum sit, alius Modus intra hos generandi reddetur vero similis? Sane in Collibus *Submarinis* non minus quam in Litoris Naturæ Officina erit instructa; addo, quod inter Ejectamenta Maris & *Lignorum Fossilium* copia in Litore *Sudarvico*, æque ac in *Neringiensi*, reperiatur: quid si Colles Alluvionibus obtekti, qui quondam Terræ Pars fuerunt? Si quoq; in Collibus submarinis reliquorum Mineralium eadem Generatio, cur non & *Succinorum*? Cæterum sicubi extra Matricem Lignosam, in Luto Cæruleo, in Terra Corticosa, Flava, Sabulosa, Vitriolica, *Succinum* nasci contigit, ne tunc quidem alia Ratio Generationis suberit: pariter enim ex *Bituminosis* Exhalationibus in Guttas condensatis *Salium* iusta Miscela, istæ Glebæ pronatæ fuerint. Neque tamen ubicunque reperitur ibidem & Nativa *Succina* sedes illico asserenda, per Maris enim vehementiam a Matrice avulsum in aliena loca sæpe rejicitur. Quin & Animalium ventriculis recondita *Succina* novi; visceribus patefactis exempta Amici Dono miserunt: nec tamen in Animalibus *Succina* generata dicemus. Ex Accolis Litoris *Sudarvici* addidici, omnis Generis Animalia, Terrestria, Aquatilia, Volatilia, avide *Succineas* Glebas deglutire, adeoque intra Mactatorum Viscera non raro observari. Corvi & Cornices tanta Copia ingerunt, ut egerere rursus vesperi cogantur, & Minutiæ complures sub Arboribus, in quibus confident, inter Excrementa reperiuntur. Ab Afellis (*Pomucheln*) deglutitæ plures mihi obvenere, insignior trium *Digitorum* Transversorum Longitudine, duorum Latitudine spectatur. Est ex Ove Globus *Succineus* Mirabilis, quem Crusta Gypseæ Mucus Ventriculi obvelarat, qua ab *Electroreuta*, imprudenter abrafa, patuit ex pluribus Glebis, a Calore Animalis subactis, fuisse formatum.

Et Mare & Terra itaque in *Prussiam Succinea* Dona confert; sed Maris Dona partim in Litore leguntur, partim ex Aqua hauriuntur: *Vadoso Soli* Mari, signis

signis apparentibus, Coloni Reticulis Conto affixi Fundum vertunt, aut Fluctibus volventibus eadem adversa opponunt: hæc quæ Haustilia; reliqua, inter Ejectamenta, quæ natantia prædæ Indicium faciebant, Algarum, Samentorum Lignorum, aut Arenarum, sedulo investigantur & seliguntur, lactaque audiunt.

Ex Terra vero, quæ fodiendo acquiruntur, Fossilia appellantur: Amam longiori Conto præfixam venæ in Montium Litoreorum jugis conspectæ, admovent, tentando sicubi Glebam Ligno immersam offendant, qua animadversa Lignum leniter radunt, imaq; subiecta Glebas excipiunt, exceptasque adducunt facculoque a Collo pendulo indunt. Fossio vero ad Venarum ductum Priscis ignoto Magni *Frid. Wilhelmi* auspiciis primum Montes exercuit. Nec tamen ubique Fossioni patet Litus, sed certorum *Recessuum* juga ista opera fatigantur; *Erofs, Gubnicken, Ekrofs, Dirfschkeim, Warnicken, Sirobschnec, Palmnig*: & sicubi Matrix Ligneæ se conspiciendam præbet, atque ad eandem facilis ac tutus est Aditus.

Succinum uti ex Matrice producitur, quod in Fossorum operas intentus ipsemet expertus sum, rigidum & durum tactu dignoscitur: Contingit aliquando frangi dum protrahitur, sed vitio Glebæ; succinum enim succino Duritiæ præstat. Non pauci tamen & prisco & nostro ævo *Mollia* ac Liquida, quidem ab altera parte dura ab altera mollia *Succina* sibi visa jactitarunt: Quæ mihi isto nomine oblata, nec Fragrantia nec Sapore, nec Deflagratione, se *Succina* probarunt: casui itaque inter Haustilia reperta *Bitumina* istis Auctoribus in *Succineum* Censum referre placuit. Verum & Picea Gleba, & Carbo Fossilis, & Segmentum Pice navali abductum, aliaque plura una a Fluctibus Maris in litus projecta, ista ratione *Succinei* Censushabenda forent. Opinio, quæ in Fundo Maris scaturigines *Liquidi Bituminis* commenta est, ut a falsugine Maris coagulatum *Succinum* haberet, *Mollia* istius modi *Succina* peperit: Neque hauriendo, neque fodiendo, neque legendo, sibi *Mollia* cognita, illi qui Rerum *Succinearum* assiduam Curam gerunt, asseverarunt omnes. Ipse, Magnos *Succinorum* Rudium acervos perscrutatus sedulo, nullum *Molle* adverti, quod Virtutis Experimento *Succinei* Generis agnovissem. Vulgo persuasum est, Discrimen Fossilia & Haustilia intercedere Duritiei potissimum, & Puritatis, ac Crustæ diversis Notis. Verum falluntur, qui istud in Animum inducunt ut credant: Evenit ut extra Matricem alienis in locis sepulcorum Robur aut Calor aliquid vitii contrahat, crassiori etiam Crusta superinducta; hi tamen Casus Nativorum differentiam minime inferrent: Æque intra Colles submarinos, ac intra litoreos, pro varia *Bituminis* & *Salium* Copia ac Virtute Nobiliora & Ignobiliora *Succina* generari certus sum.

In Glebis *Succineis* Formandis mirum Naturæ elucet Ingenium: Ut in lucem eduntur, Pira, Amygdalas, Cepas, Pifa, aliasque fructuum species, aut peregrinorum Corporum simulachra, vario lusu referunt; Guttarum his apud *Electrotorentas* Nomen, quum Globosam Figuram maxima sui parte expriment. Major Pigmentorum in Crusta denudatis admiratio. Literata Naturæ *Succina* plura vidi: Teneo in quo albescens linea Flexu suo concinne Literam S. *Latinorum* formavit, reliqua frusti facie flava: *Arabum* ac *Hebræorum* Characteres quædam ruditer exhibent. Præterea *Arbascularum, Frondium, Nubium, Rudium* aliarumque quarumcunque rerum.

rerum Delineamento in *Succino* Variegato curiosus Oculus adverteret. Est mihi Pectore tenus efficta senilis Imago, in ulna infantem reclivem monstrans; *Iesus* parvulus in *Simeonis* amplexu hærens animo obversabatur, quando primam hanc Naturæ Picturam intuebar.

Cæterum & quæ succinis Concreta adhærent, memoratu non indigna puto: Inter hæc Algæ vesicularis & tenuis Folia Rami, radicibus firmiter infixis, ex succineis Glebis propullulantes inveniunt locum; tum filex parvulus, eminentiori libera, latiori parte succino obvoluta: Alii Glebæ Lumina ferrea agglutinata est; & Segmenta Lignorum, Conchylia, variaque alia adnasci contingit.

Animalculorum succinea Funera, jam *Plinio* & *Martiali* celebrata, intentionem Curam exposcunt; ultra Triginta species Insectorum in meis *Succinis* numero; Muscas, Araneas, Culices, Formicas, Papiliones, Apes, Millepedes, Teredines, Curculiones, Erucas, Scarabæos, & ex Cornutis & Deauratis aliquot, & quorum nomina memoriam subterfugiunt. Sunt qui & perfectiora Animalia *Succino* condita memorant, Ranas, Lacertas, Pisciculos: Quibus ut fidem habeam ægre a me impetro. *Hermano* decantata Rana & Lacertæ sepulchra non uno modo mihi suspecta redduntur. Pisciculos fraude Artis *Succino* inclusus, jam aliis animadversum est. Nativa Animalculorum *Succinea* faretra ab Arte elaboratis, illo maxime distinguis, quod in istis non procul a superficie, insecta implicita reperiuntur, in his vero meditullium occupant; scil. Artem non ita feliciter occultarent *Electrotoreuta*, si extimas partes excavarant, illisque Animalcula crederent, translucida enim *Succinea* Lamina fraudem proderet. Si quoque solidum, purum, nullis Fissuris hians, nec Crustarum Compage distinctum est *Succinum* in quo sepulta sunt, illud non a Natura fabrefactum scias monumentum; pleræque enim Glebæ *Succinea*, quibus Animalculorum Exuviæ sunt repositæ, id quod Millies contuitus sum, corticatim cohærent, aut Fissuris hinc inde sunt intersectæ, ex quibus & pars Exuviarum aliquando exterius conspicienda prominet. Neque omnium intra *Succinum* reconditorum Animalculorum par est Conditio: Alia situ obducta, alia nitida, quædam *Succinea* fulgore splendentia intueor: Duas Apes & Erucam Nidumque Curculionis situs obtexit; Scarabæus fulget, ex Muscis quædam nitent. Porro alia Vivacitatem, alia Languorem præ se ferre, nonnulla quasi Evigilantia, cum Conatu vinculo isto se extricandi, conspicias. Quædam *Succina* Integrum Examen Insectorum, & ejusdem & diversi Generis, involutum commonstrant.

Vexata hinc Curiosorum quæstio, quomodo *Succinum* Animalcula oppresserit? Non pauci, difficultate Quæstionis permoti, Fœtum Arborei Succii *Electrum* contendunt, quasi Resinis aut Gummi Arborum adrepentia Animalcula irretirentur facilius: Verum absque Experientiæ suffragio; neque in Resinosi aut Gummosi Stillis hunc in modum, si recte memini, inclusa Insecta magno numero, si modo ullo Curiositas hætenus detexit, extrinsecus adhærentia conspeximus, non ita fuso liquore obtecta. Alios Gravitatis Argumenti eo adegit, ut negarent esse quæ in *Succinis* videntur Animalcula, Phasmata ludos istos dare. Sed fractorum aut fectorum inspectio hos refellit, manifesta enim Insectorum supersunt Indicia, licet enim Corpuscula Animalculorum vis *Bituminosa* ita subigat, ut Fibris *Succineis*

vineis intercurrentibus viscera condensata in Lapidem indurefcunt, quando facilis per rariorem Texturam Insectorum Effluviis *Succineis* est commeatus, tamen Corporis alieni habitum luculenter discernere datur; Apumque nostrarum Exuviz, interaneis consumptis, istud ob oculis egregie fiunt.

Funestos itaque Casus, quibus Insecta à *Succinis* sunt oppressa, ut rectius percipiamus, repetendum Memoria, quod insectis usu veniat, si quando Tempestatum aut Hyemis Injuria compelluntur, Cavernas & Latebras ubique quærere, in ibique somno sepulta delirescere. Quare cum & Litorea Latibula non unum Genus Insectorum subintret, in illisque aliquando hæreat invitum, aut obdormiscat, Exhalationibus *Bituminosis* à calore subterraneo in laticem collectis, ubi in Matricem *Succini*, quæ Latibulum ac Dormitorium interea præbuit, Liquor destillat, eadem implicat & obtegit, Gremioque suo suscepta, quando *Succinum* evasit, commonstrat. Contingit Bestiolas in Dormitoriis istis a Calore subterraneo excitari; aut in vivas Fluor *Bituminosus* impingitur; sed cum nullum vigilantibus patet Esfugium, eandem cum dormientibus sortem subire coguntur, ut tamen sortis tunc suæ in sepulchris succineis relinquant Memoriam, vivaciori atque animosiori corpusculorum Simulachro. Firmat nostram Sententiam istud, quod *Succino* sepulta insecta pleraque sint ex illorum Genere, quæ Cavernas in Dormitorio eligunt. Majorem partem etiam languida ac somnolenta aut mucosa transparent. Vivacia, quæ cum Nifu obluantur, aut Alas expandunt, abiturumque parant, rariora puta sed tantam Vivacitatem, quæ Amoris Æstu in Coitum, Animalcula concitarit, ut isto nexu Cohærentia *Succineus* Latex involvisset. Hospitio huic subterraneo minime convenire autumo; quare quæ Culicum Muscarumve istos Hymeræos ostendunt pharetra suspectis adnumero.

Speciosiora alia nunc depromam quæ Plantarum Germina sinu suo obvelant. Est mihi in quo explicata Algæ vesicularis Folia, Alas Aquilæ expansas, & Pedes cum Corpore utcunque adumbrant. Aliud Semen Tillæ, stipitisque partem; aliud Folliculum, diductis Foliis hiantem, quatuorque Semina complexum, ex quibus Apex medius exsurgit, Cauliculo ad Superficiem protenso & prominente; est quod Muscum, in Pergulæ S. Porticus Hortensis speciem, fornicatis Operibus compositum obtutui sistit. In alio Flosculus minimus marcescens, in altero Rosmarini Sylvestris, *Prussis Korbi* dicti Ramulus tribus Foliis divisus transparent; Rude aliud Algæ memoratæ Vesicularis Ramum majorem per Corticem non politum ostentat. Plura ex Musco villos disjectos obtinere; Nobile autem illud, in quo Pars albescens Convallem & Colliculum Musco investitum exhibet, sed per Speculum quasi, quando ex flavo ignei Coloris *Succino*, huic amænissimo Spectaculo mirabili Naturæ Artificio quasi Vitrum est objectum, per quod Muscosi apparatus delicatior esset Aspectus: Nec vile alterum aqueo lactescentis Coloris, quod Villorum Muscosorum crispata Congeries nobilitat. Spectabiliora hæc Herbarum *Succinea* Monumenta quam illa Animalculorum cenfeo. Major Copia Corticibus, Lignis & Festucis intertextorum; Festucæ Pineæ videntur, specie istarum quibus Formicæ Acervos

extruunt; verum accuratiori Examini Fossilis Ligni ac Corticis Monumenta patuerunt.

Ex Minerali Regno quoque adducenda, quæ *Succinis* inclusa: *Vitriolum* sæpius sapor prompte dijudicandum; *Pyrites* quandoque, crebrius *Ferrum* de quo *Electrotozenta* conqueruntur, quod non nisi cum Detrimento instrumentorum educatur; Armatura quoque *Aurea* & *Argentea*, divulsis coagmentatis Partibus, in impuro conspicitur. Sed & Aquæ Guttas intro receptas diversis Alveis stagnantes *Succina* detinent: qui effluit Liquor salus aut subsalsus, aliquando & insipidus, non exsiccare; ab aliis cum Luna crescere & decrescere Liquor traditur; habeo in quo exsiccat; habeo in quo perennat semper idem. Quæcunque autem ex *Plantis*, *Mineralibus*ve *Succinum* complectitur, casu haud absimili, dum in Matricem illapsa sunt, à Fluore *Bituminofo* obfessa atque occupata intelligo. *Aquearum* Guttarum intra *Succinum* ocellularum singularis Ratio cogitanda: Udam Matricem calida *Bituminofo* Exhalatio obsepsit, intro compulsa *Aqua* a calore subteraneo consumi nequit, & ob Copiam circumstantis *Bituminofo* Laticis nullam Rimam qua diffunderet invenit; præcluso itaque exitu, captiva se includi passa est; Conatum elabendi, quando in Arctum coacta fuit Gutta, manifestis Indiciis quædam Glebæ produnt.

Fossile Succinum declaravimus; Metallis tamen non esse accensendum, vel illud arguit, quod nec ductile sit, nec liquabile; sicubi enim in Fluorem deducitur soliditati ejus multum decedit, contra quam Metallis evenit. Fuerunt qui *Succinum* fundendi, & parva Frusta in unam Molem salva Firmitate uniendi Artem se tenere asseverarunt. Ego variis Experimentis, dum Fusioni *Succini* operam dedi, frustra istud tentare didici, siquidem salum vis, aqua maximum *Succinorum* Robur, inter solvendum avolat: nec à Fuga retinetur, nisi addito aliquo; eo ipso tamen Soliditas corrumpitur. Quod si calor tam blandus admoveri posset, qualem Natura in Animalibus humente Vapore miscet, non desperandum Arti putarem; Globus enim *Succineus* in Ovis Ventriculo repertus ex pluribus minutis coagmentatus est, relictis juncturæ ubique Vestigiis; quæ ipsa nec Fusorium, sed repidum Glutinandis commodum, Ignem à Natura adhibitum fuisse indicant. Fusa succina quibus foecula obducta atque succinea Funera venditata, Vernix sunt, uti amicissimus D. *Vogeding* optime monuit. Solvi olim *Succinum* & liquefecit, solo Ignis adminiculo, nulla alia re admixta, sed fragilius justo comperi, imminuta Coloris Gratia, Salinis Minutiis quæ Lateribus Vasis adhærebant causam reddentibus. Multo minus ad *Terrarum* aut *Salium Classem* *Succinum* referendum erit; quum Terris arctius cohæreat, & Salibus sit pinguis, utriusque etiam humidius. Ad *Bitumina* & *Sulphura* propius accedit; ut tamen Durities ipsum ab his discriminet, tam dura enim ac solida pura *Bitumina* aut *Sulphura* nemo indicabit.

Durities vero *Succinum* inter *Lapides*, Splendor inter *Gemmas* collocat; neque Fragilitas obiciatur; Fragilis & *Gagates Gemma*que *Gemmis* solidiores, nec tamen propterea Loco moventur: *Electrotozenta* satis dura *Succina* experiuntur, alba in primis, ut ferri Aciem hebetent; Tormentaque et Mortaria

taria Ludicra, à Pulveris Pyrii Explosione illæsa, Soliditatem docent. Summa etiam Succini ex duritie & soliditate Gloria: faceffant itaque friabilia ac fragilia, quæ Ignobilitate contempta ab Arte rejiciuntur. Sed Virtutum quæ Succinum à reliquis Gemmis discernunt, præcipua antiquis visa *Attractiva*, ut *Electrica* ipsis vocarentur Corpora, quæ facultate trahendi quidpiam ad se pollerent; & celebre hujus Virtutis Nomen *Platonis* etiam ingenium in explicando exercuit. Recentior *Ætas*, quæ res naturales intentiori *Experimentorum* cura explorat, aliis Gemmis, Lapidibus, Vitris, Bituminosis, Resinosisque, Sulphuri, Asphalto, Laccæ, communem vim *attrahendi* advertit. Reliquis tamen Gemmis fortius Succinum attrahet, ut quod attritum pingua Effluvia eaque *Tenacia* copiosius emittit: Virtutem enim hanc oleosis particulis adscribendam persuasit *Experimentum*, quod de *Colophonia* gemina cepi; altera enim post olei destillationem excepta pariter se *Electricam* adducenda levia probat; altera vero, quam post Balsami nigri Liquorem exemi, licet *Nitida* & quasi *Vitrea* esset, nullam vim *attrahendi* exerebat; nimirum illa, aliquid *Pinguëdinis* retinuit, hæc vero *Capitis Mortui* instar omni *Bituminosa* *Pinguëdine* prorsus exuta fuit. Veteres quædam exceperunt, quæ non adduceret; *Sympathia* & *Antipathia* Miraculo; perperam admodum siquidem & *Ocymum* & oleosa & humida, ipsasque aqueas *Guttas* à Succino attrahi pro lubitu demonstro, insigni & polita *Gleba* admota; eleganti *spectaculo*, quando effluviis Ingredientibus *Gutta* in *Bullam* adsurgit, aut quando pendula transilit. Sed & in Corpus humanum hac Virtute Succinum agit: frusto Cervici alligato partem, quam leviter attingit, leni Sudore *Humectam* tactu percipies. *D. Boyle*, *Angliæ* primo *Europæ* eruditæ maximum quondam Decus, enarrabat & incredulo mihi asseverabat, illustris *Prosapie* Virginem *Globulorum* grandiorum lactei albescentis *Corolla* ita affectam, ut os in tremorem & quasi *Spasmus* ageretur, quoties Collo suspensam gestaret, remota vero *Corolla* Tremorem cessasse & Convulsionem. Efficaciam autem attrahendi Humores in Fonticulis quidam Globulis *Succineis* persensere.

Propria Succino est *Fragrantia*, qualem nulla *Gemmarum* exhalat; neque ex reliquis Naturæ Foetibus, *Aromatica* fortis quidquam parem odorem spargit; non *Thus*, non *Myrrha*, non *Camphora*, nec *Mastiche*: in resinarum intra *Formicarum* *Acervos* abditarum Globulis imitamentum habes *Odoraminis*, sed ut in attritis & accensis discrimen se prodat illico. Diversus est *Flavorum* five *Ignorum* ab albescentibus Odor; illorum pingua, adeoque blandiora, horum salsa & acriora sunt Effluvia, quæ hæud similiter *Naves* afficiunt. Peculiaris quoque inter *Gemmas* *Succinis* est Sapor; sed & hic variat, uti *Oleosarum* & *Salinarum* *Particularum* variat *Miscela*; alba *Fibras* *Linguae* pungunt, flava non item. A plerisque Gemmis & Colorum *Varietate* differunt: nigrorem refugiunt; *Opaca* rara sunt reperta; superant inter *Pura* pellucida. Denique, *Levitatem* parem vix nominabas *Gemmam*.

Princeps Virtus Corporibus Animalium mederi, ad quam *Gloriam* nulla *Gemma* æque accidit; crudum citra Artis *Operam* est salutare; five intus five extus applicetur, *Indis* & *Chinensibus* suffitus in deliciis habetur, ut in luxum degeneret; sed *Catarrhis* ex *Pituita* suffimentum prodesse vulgus notavit; *Exhalationibusque* *Succineis* *Alexipharmacis* acceptum quondam tulerunt *Electro-*

reuta Regiomontani, quod ipsi a Peste manserunt intacti; certe non efficacior adversus Contagia sufficit, quam ex Succino; neque ulli ex Fodinis Litoris *Sudavici* graves aut pestilentes erupere unquam Vapores. Fluxionibus Capitis alba perpolita Succina sunt proficua, Cervici alligata humores avellunt; blanda quoque Oculis *Flavorum* affricatio; & Fonticulis *Succinei* Globi lenius induntur. In Pulverem contusum ad Urinam ciendam, ad Calculum propellendum, ad Muliebris Sexus menstruum Profluvium movendum, multum valere, si cetera sunt paria, quotidiana loquitur *Experientia*. Dono à generosa Domina acceperam Calculum plurimum *Unciarum*, duos Articulos Digitorum & supra latum, tres longum, quem carnificem Rustica in Sinu Pudoris tres Menses passa erat; dato *Succini Albi* Pulvere, *Cochlearis Mensura*, feliciter Carnificina liberata est; ipsam aniculam ad me adduci curavi, ut omnia exquirerem accuratius. Pariter *Succini* Pulvis, Vino infusus, hinc sub operculo incoctus, calido Vino epoto, & Urinæ & Calculo, & Mensibus trahendis infervit, quamvis minus efficaciter. In memoratos Usus Medicos præstat album fumere; salis enim maxima in his enitet Virtus.

Magisterium Resinosum salubriter *Pilularum Forma* usurpatur, nec *Balsamo Copaitæ* cedit; sive Urina cienda, sive Pituita generanda, sive Gonorrhæa temperanda: Idem Cephalicis Emplastris convenit. *Colophonia* Diaphoreticis quibusque & Stomachicis Emplastris congruit; commodo maximo si adversus Paralyfin, Apoplexiam, aut Epilepsiam, aut etiam Gangranam muniendæ sunt Partes, sumptu minori: Debilitatos ab Arthritide Artus benigne fovet Oleum *Succini Europa & Asia* præclarum præbet Medicamen, sed imprudentia. Medicastrosum infamiam incurrit; siquidem in Gonorrhæa, Calculo & Mensibus suppressis sæpe in exitum ægrotis cessit: Parca ejus sit dosis, Gutta una & altera aliquot Drachmis sacchari vires impertit: Frigido Pituitoso Cerebro una Guttula Vertici aut Sururis illita medetur, Gossypio excepta Auribusque admota Flatus & Tinnitus discutit, Ambustas frigore partes restituit; Partui difficili fert opem, quod vel Veterinariis in Prussia innotuit, quamvis his Pulvis magis in usu. Oleum autem eligendum quod Aërium, nulla ab igne nota *Emphyreumatis* impressa, Albescens, subtilissimum & fragrantissimum. Salis Volatilis *Succinei* contra Epilepsiam aliosque affectus Cephalicos à Pituita oriundos decantata est Medicina: Sed & Diureticum insigne præstat. *Essentia Succini* est Olei subtilior portio, adeoque eadem de hac tibi promittis commoda, sed quæ Spiritus Vini Mixtura diluta est largius in usum assumi potest: valet quoque ad arcedam Gangrenam extus. Sunt qui Phlegma medicamentis adnumerant: Sed quodcunque ipsi inest Virium, Olei atque Salis reliquiis deberur, quibus si privatur Patuum, ac fumosis Exhalationibus imbutum restat. Quod postremum destillat crassum Oleum non nisi vulgo in frigidorum Artuum Medetam conveniet, *Emphyreuma* enim graveolus reddit, ut satius æstimem isto abstinere, & Colophoniam integris Viribus servare.

Illud unicum adjicio, me iusta *Analyfi* ductu Naturæ pura ab impuris separando, blando in subsidium advocato Igne, vires Succini omnes ita coadunare, ut salva *FrAGRANTIA NATIVA*, Pinguium & Salinarum Particularum salva quoque *EFFICACIA*, externo internoque usui idoneum Remedium evadat. *Balsamum Succineum* voco, in quo remotis terrestribus graveolentibus partibus volatiliores.

liores atque delicatiores amicissimo floris nexu Arctæ cohærent, nullo alieno in Societatem admisso. Quicquid a Succino crudo aut Arte quomocunque *præparato* expectari potest, citius, tutius & jucundius a nostro *Balsamo* præstabitur. Interne forma *Pilularum* commodissime assumitur, aut Boli; externe Apoplectici, cujus & Colorem præ se fert, *Balsami* in modum applicatur, Gingivis, Lingux, Palato, in *Deliquiis*, in *Passionibus Hystericis*, *Epilepticis*, *Paralyticis*, cum fructu affricatur; Prophylaxeos ergo quavis septimana bis terve *Grana* 5, 7, 10, imo 15, tuto usurpantur; similiter in Renum, Vesicæ, Genitalium certis Morbis, admixtis Anodynis, contra tinnitum Aurium quam Oleum affert Medelam, at certiolem. Non male apud *Hofmannum* & *Etmullerum* *Balsami Peruviani Gratia* Oleo Succini jungitur. Ast felicior *Peruviani* & nostri *Balsami Succinei*, adversus Gonorrhæam & Fluorem Album imprimis, Societas erit.

Succinei notior est Destillatio, quam ut describi opus habeat. Et XX. & retorta huic negotio inservire valent, verum per Rimas multum Olei & Salis elabitur si XX. adhibes. Vehementissimam enim Olei & Salis vim nullum *Lutum Philosophicum* coercebit; præstat igitur retortæ Opera uti, attendendum autem ut alba si Salis si Olei copiam elicere satagis, ut flava eligas; ex lb j. albi recepi Salis Volatilis $\frac{1}{2}$ Unc. quum ex flavi lb j. vix elicias. Felicius quoque & suavius Oleum proveniet, si polita *Fragmenta* aut nitida, tenui Cortici lucida frusta, quam si impura, *crassa Crusta investita*, aut vulgarem *Rasuram* adhibueris, nihil autem Succino est admiscendum, quamvis Silices & Arenas addere olim fuit in usu. Absit Ignis vehementia, ex Arena Calor leviter intenditur, atque justo Regimine mox cum Phlegmate Ætherea Olei portio ascendit, quam limpidam peculiari vase excipies, ubi flavescens Oleum prodiit cum Sale Volatili cesset Destillatio.

Urgeri quidem potest Succinum, ut crassum Liquorem nigrum fondat, parumque capitis Mortui nigri & splendentis instar Colophonix erit Residuum; sed hoc omni virtute Olei & Salis est spoliatum, ex lb ss. albi restabat Unc. hujus Capitis Mortui. Sed præstat aliquas Colophonix vires relinquere; quando gravior hujus præ fœtido nigro Balsamo est usus. Sal Volatile, quod ad Rostrum Vasis evolavit, aut Lateribus adhæsit, calida Aqua abluitur, atque ut ab admixtis Oleosis particulis separetur, *Charta humefacta* solutio percolatur, transeunte Sale, restitat Oleum, a *solutione percolata* postea superfluous Humor abstrahitur, ut *tertia Pars* relinquatur, quæ frigori exponitur, atque singulare *Salis* concrescunt Chrystalli, Miliæ quasi sive Grandinosi. Alius est modus Sal depurandi, si feculentum vitro longioris Colli inditum Cinerum aut Arenarum Calori exponitur. Nives enim Floccis, sive Spiculis ad sublimiora Loca evolutibus, in Fundo impurior pars hæret, verum hæc Operatio cum jactura Vitri & Salis est conjuncta. Quidem & Phlegmati separando student, verum rectius hoc cum *Aqua*, quæ *Sal Volatile* imbibit, jungitur; ut pariter Sale sua exuatur, neque *reiterata Destillatio* illi conciliabit Virtutem, nisi a *Sale Volatili* illam acceperit, nec gratus Phlegmatis Odor, ut in *Salis Volatilis Conservationem* commendari posset.

Accipi:

Accepi ex lb ss. *Albi Phlegmatis* $\frac{1}{2}$ *Unc.* quod Salis Succinei sapore erat imbutum, repetita autem Destillatione fumum solum sapiebat, cætera Fatuum & ingrati Odoris. In Colophonia, si non prorsus fuerit exusto, aliquid Salis latitat, quod ope Aquæ calidæ, mora quadam *Macerationis* educes: nonnullis hoc Sal fixum Succini audit; non recte, quia parilis Volaticæ est Virtutis, Sapore & Odore eodem: Colophonix autem Virtutem hoc quodcunque est Salis intendit. Oleum omne, at alia opera depuretur non opus est, modo recipiens vas justo tempore mutetur, atque rite instituatur Destillatio, purissimum statim accipies. Qualitates Olei Succinei ex Bitumine sive *Oleo Terræ* sunt derivandæ, qua in re *Ol. Borrichio* minime refragor; sed quod idem omnes Virtutes Succinei Petræ Oleo vult communes, in hoc dissentio: alteratum enim Succineum Odor & Sapor ab illo Olei Petræ aut Terræ diversus demonstrat; at Olei ex Ligni fossilis destillatione, Odor Olei Petræ, non autem Succinei Odori congruit: Credo autem Alterationem Olei Terræ in Succino Salium intimæ deberi Combinationi. Quænam vero ista sint Salia determinare non licet, illa ipsa tamen erunt quæ Succini Sal Volatile sua *Mistura* progenerant. Nullum enim est Succinum, cujuscunque sit Coloris, quod Sale Volatili destituatur, atque à Sale Volatile omnis ista peculiaris *Fragrantia*; quantoque Sale abundant, tanto in attritu *Fragrantiora* experieris. Ut autem temerarium Naturæ *Arcana* definire, ex Vitrioli tamen *Martialis* Corpore Sal istud Succineum majori ex parte componi citra Crimen audacter assero; etenim in albis Sale Volatili insigniter pollentibus, & Odore & Sapore Chalcantum tale manifesto deprehenditur. Sed minime communi Vitriolo Sal Succini adscribimus; *Vitriolum alteratum* sit oportet, quod tale Virtutis singularis Sal Volatile producit. Esse autem *Vitriolum Prussicum* ab aliarum Regionum *Chalcantio* diversæ Naturæ, Analysis inferius declarabit.

Certe ab Acido Originem trahere Sal Volatile, acidus, isque non ingratius, ferme vinosus Sapor arguit; ad *Spiritum Vitrioli Philosophicum* proxime hæc gratia Acoris in Sale Volatili Succini accedit; pungit, minime corrodens, affusoque Spiritu Vitrioli non effervesceat neque ebullit, nec consumitur, cum *Sp. Salis Armon.* commissum Bullulis excitatis cum stridore absorbetur. Subtilissimum hunc & gratissimum Volaticum Salis Succini acorem Moderationi Bituminosarum Exhalationum vindico, quemadmodum *Sp. Vini* cum Spiritibus Nitri, aut Salis combinatus, hos mitiores reddit, ut dulces audiant. Siquidem dum Bituminis Particulas dispersas Calor subterraneus in unum cogit, fit ut hæc per Ditiones Vitrioli transitum faciant, quas dum permeant, subtilissima Vitrioli Effluvia eodem Calore excitata secum rapiunt, minori, majorive Copia, atque in *Matricem Ligneam* auferunt ut junctis semiis Succinea pronascatur Proles.

Succini qua in Pollinem terendo redigitur, levior est *Preparatio*; equidem parum interest Pulverem contendendo an terendo minutum exhibeas, scilicet utroque modo prodest, vel Brutorum Exemplo, quæ avide *Succinorum* Minutias devorare annotavimus. Verumtamen quod Divisio in minima ad faciliorem commissionem cum Succo nativo Animalis disponit, non inutilis in Medicina ista erit Opera. Infusionem *Succini* aut Coctionem præterirem, nisi inter Euporista

Euporista Domestica merito hæc *Præparationes* locum sibi dari poscerent : certum est, quod *Virtus Succini* coquendo in vinum transeat ; sed infundendo atque digerendo vinum *Succino medicatum* impetrabis. *Essentiam* sive *Tincturam* affusus *Succino Sp. Vini* parat, qui tamen à puris albis Flavescere non tingitur ; an *Sp. Vini* igneus præstet, an dilutus, in dubium vocaveris, illum enim *Oleosa* hunc *Salina* partes deponunt, verum cedit *Succinum* utrique & per *Digestionis* quamcunque moram necesse est, ut *Sp. Vini* tandem reddatur dilutior, præferendus itaque generosior. Felicius autem *Tinctura* proveniet, si *Ramenta* tenuissima cum *Sp. Vini* sociaveris : quidam *Ol. Tartari* per Del. aut *Salis Fixati* addunt, aut his *Sp. Vini* acuum, ut major virtus & ocus in Spiritum transeat, non male, nisi quod alieni Particeps hæc evadat *Tinctura*. Sed & Ebullitione in vitro oblongi Colli *Succinum* felicius dissolvitur, ut virtus prompte suscipiatur, & Spiritus illa saturetur penitus, id quod sola *Digestio* longissima Mora demum assequetur.

Majores *Magisterium ex Succini extracto* per Acidum redigere fategerunt, nullo opere *Prærio*, si Acidum *Succini Pulveri* associare cupis, terendo idem assequeris rectius. Præstantius *Magisterium* dabit *Tinctura abstracta* *Sp. Vini Resinosum* istud est, imo ipsa *Refina* sive *Oleosa Pars Succini* qualemunque mutationem passa ; siquidem *Sp. Vini* quem destillando recipis *Succineis Viribus* impregnatus intimam sui cum *Succino* unionem indicat.

Ligni Fossilis Fragmenta contusa *Aqua Calida* maceravi, *Lixivium* subdulcis *Aluminosi* aut *Martialis* potius erat Saporis, ut ægre tandem aliquid *Vitriolici* pericentisceres ; sed ad *Chrystalos Salinos* congregandos inspissatum, magis atque magis *Vitriolicum* Saporem prodebat, ipsique *Chrystalli* eundem referebant, nisi quod primum *Martialis Dulcedo* Linguam afficeret : id quod repetendo *Solutionem* & *Corporationem* in *Chrystalos* denuo expertus sum. Exutum Sale Lignum retortæ indidi ; & Calore *Arenæ* intensissimo, ut intra vitrum *Fragmenta* canderent, omnem Humorem elicui : Lacteus prorsus erat Liqueor qui prodibat, specie Emulsionis *Amygdalarum*, quadam postea in Superficie Cuticula, & subsidentibus in Fundo particulis Calciformibus. Odor gravissimus Sulphureus qui totum *Hypocaustum* illico pervadebat ; sed propius admoto Liqueore Nares Succineum quid percipiebant, non quidem *Fragrantis* Glebæ aut Olei, sed *Phlegmatis* ut post Destillationem in Retorta residui : Sapor quoque qualis *Phlegmatis*, fumosus ab *Empyreumate*, falso Aciduli, quidpiam Gustui intermiscens. Lacteus Color in Liqueore postea disparuit, pinguiori Relicta Cuticula. Denuo Partem Igni feci exponi, si qua *Sal Volatile* & puriores Olei Guttas reiterata Destillatione exciperem : Verum *Salis Volatilis* nihil ascendit, *Oleosa* autem Particulæ subtiliores inuatabant, non amplius in modum Cuticulæ coherentes ; quædam etiam Forma Globulorum pellucidorum fundum petierant, igneo Succini Colore conspicuæ. Exigua Portio Olei, aliquot Guttarum ex lb j. Liqueoris, Sapore & Odore Oleum Petræ prorsus imitabatur. Globuli vero, ut in Fundo Resinosi apparerent, levi Concussione Liqueori commiscebantur.

Calciformes.

Calciformes Particulæ tenuiori terrestri Portioni adscribendæ erunt, Ignis vi fursum elatæ.

Lignum ex Retorta exemptum Brunno Ferruginei erat Coloris, multum *Sulphuris exhalabat*, accensum instar Fomitis Ignem alebat, Superficies ejus leviter Rubro Pulvisculo conspersa fuerit.

Crucibulo impositum per tres Horas Ignis exercuit, refrigeratum pariter *Cinnabarino* quasi Pulvisculo obtectum fuit: Flammæ admotum minus prompte Ignem suscepit, neque diu detinuit, nedum ut Fomitis instar propagasset, spirabat autem *Sulphur auratum*, hujusque Saporem commansum præbuit; accensum vero minus *Sulphuris exhalabat* quam quod in Retorta erat relictum: Colore etiam lucidiori. Denuo in Crucibulo ultra novem Horas detinuimus, neque accendi amplius potuit, sed instar *Amianthi* album post Ignitionem comparebat, nullo *Sulphuris* Odore. Color post tam longam in Crucibulo Moram ex *Griseo* partim nigricans, partim splendens; Microscopii ope aliæ partes instar Scoriarum, aliæ instar *Chryscollæ*, aliæ instar Calcis efformatæ dignoscebantur. Tostum atque exustum satis *Lignum* felle Vitri admixto, Igni Fusorio exposuimus; & facile coierunt in *Massam*, quæ Granulæ disparia *Reguli Martialis* exhibuit postea. Dum vero in unum Corpus ista Granula fortiori Igne cogere intendimus, *Colliquata* cum Regulo Massa, ex nigro splendens, Vitrea producta est.

Nativum Vitriolum, sive illud *Amianthi-forme*, sive Fusum alterum, attritu *Chalybis* prodit sibi non cum *Venere*, sed cum *Marte* Societatem initam; nullam enim Cupri indicem Rubedinem relinquit. *Nativum Amianthi-forme* solum & in *Chrystallis* redactum idem confirmat; subdulcis enim ac plane *Martialis* primo Sensu percipitur Sapor, qualis Salis sive Solutionibus Martis Chrystalli non ista Specie qua *Goslariense* concrevunt: Solutionum autem prius depurgavimus affusa Urina, atque semotis Facibus concrevit *Terra Foliacea*, reliquus Liquor *Chrystallus Sappharini* ferme Coloris inæqualibus Angulis exhibuit. Cæterum ex Solutione inspissata hincque *Filtrata*, succedente Evaporatione, album *Oleum* prodiit, quod Furno Pistoris leviter calcinatum Loricatæ Retortæ inditum *Sp. Vitrioli* intra 24 Horas fudit egregium, qualem ex *Oleo Martis* alias Officinæ parare solent. In *Colchotare* multum Salis Olei adhuc latere, ope Microscopii exploravimus, ut pateat quomodo *Oleum* in *Colchotare* Aeri exposito regenerari intelligendum.

Terram Corticosam ejusdem cum *Ligno Fossili* esse Naturæ Ignis Examen confirmavit; leviori Tostione Opus erat ut ex hac aliquid Metallici eliceremus, licet quod obtinuimus exiguum esset. Ex *Luto Caruleo* olim per Destillationem Spiritum nactus sum Volatilem *Sulphurei* Odoris & *Bituminosi* quid in Superficie comparebat. Terram vero *Flavum* ad Martem inclinare adverti, & *Vitriolici* aliquid traxisse ex Confinio Sapor arguit & Odor.

Inter *Regias Opes*, antiquissimis Temporibus, *Thesaurus* hic *Succinorum* repositus fuit *Regibus*, qui Terras *Succiniferas* tenuere jam olim *Succina* colli-

colligentibus ; ut Magnificentia Munerum aliis pares essent. Apud *Selinum*, *Rex Germania* (*Prussia* intelligendus, quam *Germania* tantis opibus *Succineis* nunquam gavisa sit) tredecim millia Librarum *Neroni* Donum misit, non unius sed plurimorum annorum congestus Acervus. *Prussia* inter Regalia *Crucigerorum* ordini *Succina* vindicavit, aliquo in eadem *Episcopi Sambienfis* iure. Atque publica Autoritate Collectio est instituta, severis in depeculatoribus legibus. Secessione Civitatum ordinis *Ærarium* accisis *Succini* redditibus non leve detrimentum passum est, quamvis obnixè omnia ageret ut integro *Thesauro* solide potiretur. Post *Crucigeros* Ducum *Prussia* quæ fuerit in severandis *Fisco Succinis* cura. *Annales* potius eloquuntur : Destinati tamen operi memorantur Litoris *Sudarvici* Coloni, quibus ex *Capitaneatibus Schakenfi & Fischufiano* additi sunt alii : Servituti non statim dies, sed si quod capturæ tempus commodum, diu noctuque, Hyeme æque ac Æstate. Stipendium his, *Domus instructa & Agellus*, atque a *Tributis* immunitas ; haustique vel lecti *Succini* modius modio *Salis* redhostitur. *Fissili* præsens pecunia adjicit *Auctarium*. *Crucigeri* *Dominum Succinorum* vocabant qui *Succineis* rebus præerat ; alicubi & *Commendatoribus* ista *Cura* incumberebat. Sub *Divo Alberto* Magistrorum atque postea *Camerariorum* nomen frequentius fuit, *Equestris* dignitatis viris hoc Munere defungentibus : *Nostri* *Ætate* partem muneris capit *Capitaneatus Fischufani* *Præfectus*, partem *Feloniorum* *Director*, *Administratore* Litoris *peculiari*. *Administratori* *Custodes* Litoris *Equites* (*Dimcnd Keuten*) præsto sunt ; *Equitibus* autem adjuncti sunt servi *Cameræ* (*Hunmer Musta*) qui *Pedestres* cum *Equitibus* *Munus* custodiendi alternant, quandoque si opus est, & horum vices obeunt.

Administratoris *Officium* est ad operas ordinandas iussa edere, *Succina* undique recipere, congesta *Regiomontium* transmittere, *Furta* præcavere, de inventis disceptare, & *Regale* serenissimi ubique inviolabili præstare. Hujus etiam est *Sal* *Colonis* distribuere. *Equites & Servi Camera* *Litus* de die obequitant aut circumeunt, ne quis *Succina* tollat ; iidem tempestates observant & *Colonos* si hauriendum fodiendumque convocant, *Fossus*que & *Haustrum* recipiunt. Nulli *Colonorum* *Succina* detinere domi licet, sed ad *Equitem* aut alium, cui istud delegatum, deferunt ; quæ in *Pillavia & Neringia Recentioris* *Litore* leguntur, scriba *Felonii* ab his suscipit. Si quando *Angustia* temporis, insigniori *Copia*, in *Litore* seligere non permittit, *Domum* asportandi *Facultas* concedetur ; vi *juramenti* autem proxima *Luce* eadem reddunt. Inter hauriendum & fodiendum *Operariis* *Sacculus* a *Collo* pendet, & *Furti* reus habetur qui *vestimento* *Glebam* abdidit. *Recepta* a *Colonis* *Administratori* exhibentur a quo *Regiomonti* in *Succinorum Camera* reconduntur, atque præsentem *Directore Feloniorum* discernuntur & dividentur. Olim plures *Succinorum Camera* erant, *Lochseti*, *Dirschkeimi*, *Memela*, *Germovia*, singulisque sui præerant *Magistri*.

Extra *Litora*, *Succina* in *Prædiis* *Fisci* reperta *Præfectis* sunt restituenda ; quæ in *privatorum Fundis*, si non *Privilegio Domino* vendicari poterunt, *Fisco* necesse est pariter cedant ; quamvis hætenus *privatis* invidendas ex *Succino* opes obtigisse non memini.

Quondam *privatis Succinorum* *captura* erat elocata, ut certa *Annua* sum-

ma præsentis Pecuniæ 10000 aut 12000 Talerorum redimeretur, præterquam quod in Colonos impensæ erant faciendæ. Verum plus Questus ad Fiscum rediit, postquam publica Autoritate non solum curata, sed & divendita sunt *Succina*, certo pretio cuilibet generi *Succinorum* ad Mensuram statuto.

Succineæ Rudes Glebæ in auctarium pretii discernuntur, Capitales (*Haupt Stuck*) aliquot *Unciarum* pondere, carius veneunt; Tornatiles (*Dubly*) *Palma* Longitudine ac Latitudine minoris constant; Minimæ (*Kraufs*) his cedunt. Illis autem, quæ aliquot *Librarum* pondera æquant, nulla certa est Æstimatio. Puritas, dignitas Coloris, pretium adauget; vilissima habentur impura (*Dihluc*) pretiosissima *Alba Lactea*.

Crucigeris Dominis, *Lubecenses* & *Stolpenses* *Succinorum* Commerciis inclauere; postea & *Gedanenses* atque *Regiomontani*. Nostra Ætate *Gedanensium* maximus ex *Succinis* est Questus, postquam Mercatores *Prussici* ad se traxere, *Electrotoreutarumque* Collegium quæ *Neringia* Recentis Litus offert, solide possidet. Cruda *Orientalibus* Populis magno Pretio venduntur; *Armenique* & *Persæ* olim *Regiomonto* asportari curarunt, Lucro Civium non contemnendo. Cæterum Ars *Electrotoreutarum* majorem Questum facit, Sculptura ac Celatura aut Torno varias Figuras inducendo, ut inter pretiosissima habeantur ex *Succinis* fabrefacta opera. Operibus pretium intendit si ex eadem *Massa* integra confecta, si nobilioribus Coloribus sunt conspicua, si rariora Naturæ Pigmenta monstrant.

Primus ego persuasi, ut *Italos* & *Gallos* imitentur, qui Effigiem Rerum & Animalium Segmentis aut Tessellis *Gemmarum* ingeniose componunt. Et succederet opus, si supremi Domini iussa accederent, Facultasque daretur eligendi quæ ad *Vermiculata* sive *Musiva* istiusmodi Opera requiruntur; etenim opaci Colores, quibus Ars maxime indiget, in *Succinis* occurrunt rarissimi. Neque solum Arte *Toreutica*, sed & *Pharmaceutica* ex *Succinis* Lucrum redigi potest; quum *Agyptæ* circumforanei adulteratis Oleis & Balsamis *Succinorum* tantum Argenti lucrentur. Præterea *Vernicis* & *Succino* magnus est usus; atque *Lacæ* non cedit *Succinum*, si recte præparatur. Infectores quoque Pellium, *Russi* imprimis ac *Judæi*, *Succinum* opere adhibent, ut & horum Ratione ex *Succino* Questus promitti queat.

An odd sort
of Amber, by
M. Hevelius
n. 54. p. 2051.

LXV. I lately received from one that liveth on the side of the *Baltick Sea*, a Piece of *Amber*, which is so soft that I printed my Seal on it. It is yellowish as most *Amber* is, transparent and burning as other *Amber*, but its Scent stronger, as if it were a kind of Glutinous *Bitumen*; and yet it hath been cast up from the Sea this Year, and was found among other Pieces. A very credible Person related at the same time, that he had been Master of a small Piece of *Amber*, soft on one side, and very hard on the other, wherein lay buried a Fly.

n. 66. p. 2052.

Succinum quod Sigillo cedit inter omnium rarissima quæ apud nos reperiuntur; merito habetur; quippe dum vixi, si bina illa Frustra, quæ penes me habeo, excipias, ne unquam quidem vel minimum Frustrulum vidi, ut tale a multis Annis sollicitè quæsserim. An unquam Frustrulum, altera parte molle, altera durissimum, possim impetrare, valde dubito.

LXVI. The

LXVI. The chief Fisher upon the *Inland Poisonous Sea* near *Dantzick*, informed me, that 2 or 3 Years ago fishing in this Sea, his Net brought up a considerable large Piece of *white Amber*, which was a Rarity he presented to one of the chief Fathers of the *Olives Abby*, to which this Sea belongs. Now since this Sea lies high, and about 3 *German Miles* distant from the Ocean; and since also the neighbouring Woods, that bear none but highly resinous Trees, cannot be reasonably said to furnish such *Amber*, that Conjecture, which imports that *Amber* is a *Bituminous Fluid Substance*, hardened by the *Aqua-aerial* Particles upon it, may receive some Confirmation from this Account.

White Amber, by Mr. Kirby. n. 82. p. 4052. Vol. Sup. Cap. II. c. XXIII.

LXVII. Having occasion in *July 1674*, to view certain Fossils, which I had disposed into divers Drawers in a Cabinet made of *Barbadoes Cedar*, I observed many of the Stones in every Drawer, (and some were lapped up in Papers) to be thick covered over with a liquid Rosin, like *Venice Turpentine*; tho' after diligent search, there appeared no manner of Exudation in any part of the Cabinet.

The Electrical Power of Stones, in relation to a Vegetable Rosin, by Dr. Lister. n. 110. p. 224.

Of the many sorts of Stones I there had, divers escaped, but not any of the *Hematites* kind; having therein *Manganes*, *Scistos*, *Botryades*, &c. which were all deeply concerned, and amongst perhaps 500 Pieces of the *Astroites* here and there one or two in an Apartment, and sometimes more were seized, and the rest dry; as it fares with People in the time of the Plague in one and the same House. I further observed that Stones of a soft and open Grain, as well as those of a hard and polish'd Superficies, were concerned in a manner alike.

'Tis certain, that the whole Body of the *Turpentine* of the *Cedar-Wood* was carried forth into the Air, and floating therein, was again condensed into its own proper Form upon these Stones. This makes it more than probable, that odoriferous Bodies emit and spend their very Substance. Thus *Camphir* is said, if not well secured, totally to fly away. Again it is hence evident, that there is great difference betwixt the Distillation of Vegetable Juices, and the Emission of Effluvia, or this natural Distillation: That really separating and dividing the Substance into different Parts; but this carrying out the whole entirely and unaltered in its Nature.

LXVIII. Non solum *Succinum* & *Gagates* allecant Corpuscula, sed & *Adamas*, *Saphirus*, *Carbunculus*, *Iris Gemma*, *Opalus*, *Amethystus*, *Pseudo-adamaneas*, *Bristoliensis*, *Berillus* & *Chrystallus*: Item *Hyacinthus*, *Granatus*, *Böhemicus*, *Vitrum*, & ex *Vitro* sive *Chrystallo*, *Gemma Adulterata*, *Vitrum Antimonii* & *Saturni*, Omnes *Fluores ex Fodinis*, *Belemnites*, *Sulphur*, *Mastix*, *Cera sigillaris ex Lacca*, *Resina Durior*, *Arsenicum* sed *imbecillius*, & *Cælo sicco Sal Gemma*, *Lapis specularis*, & *Alumen Rupeum*.

A Catalogue of Electrical Bodies, by Dr. R. Plot. n. 245. p. 384.

Ambergreece
a Vegetable
Production,
By . . . com-
municated by
R. Boyle, n.
97. p. 6113.

LXIX. 1. The several Trials and Observations of my own about *Ambergreece* having long kept me from acquiescing either in the vulgar Opinions, or those of some learned Men concerning it; yet I confess, my Experiments did much less discover what it is, than the following Paper has done, in case we may safely and intirely give credit to its *Information*, and that it reach to all kinds of *Ambergreece*. And probably you will be invited to look upon this account, tho' not as compleat, yet as very sincere, and on that score credible, if you consider, that this was not written by a *Philosopher* to broach a Paradox, or serve an Hypothesis, but by a *Merchant* or *Factor* for his Superiors, to give them an Account of a Matter of Fact; and that this Passage is extant in an *Authentick Journal*, wherein the Affairs of the *Dutch* and *India Company* were by publick Order from time to time register'd at their chief Colony *Batavia*, which was lately taken in a *Dutch East-Indian Prize*. And it appears by the Paper it self, that the Relation was not looked upon as a doubtful thing, but as a thing from which a practical Way may be deduced to make this Discovery easily *Lucriferous* to the *Dutch Company*.

' *Ambergreece* (says the Journalist, Mar. 1. 1672.) is not the Scum or Excrement of the Whale, &c. but it issues out of the Root of a Tree, which Tree how far soever it stands on the Land, always shoots forth its Roots towards the Sea, seeking the Warmth of it, thereby to deliver the fattest Gum that comes out of it: Which Tree otherwise by its copious Farness might be burnt and destroyed. Where-ever that fat Gum is shot into the Sea, it is so tough, that it is not easily broken from the Root, unless its own Weight, and the working of the warm Sea doth it, and so it floats on the Sea.

' There was fund by a Soldier $\frac{1}{2}$ of a Pound, and by the Chief, two Pieces weighing 5 Pounds. If you plant the Trees where the Stream sets to the Shore, then the Stream will cast it up to a great Advantage.

An Animal
Production,
by Mr. Robt.
Tredway, n.
232. p. 711.

2. An ignorant Fellow in *Jamaica*, about two Years ago, found 150 Pound Weight of *Ambergreece* dash'd on the Shore, at a Place in these Parts called *Ambergreece-Point*, where the *Spaniards* come usually once a Year to look for it. This vast Quantity was divided into two Parts; supposed by Rolling and Tumbling in the Sea. This Man tells me that 'tis produced from a Creature, as Honey or Silk. And I saw in sundry Places of this Body, the Beaks, Wings, and part of the Body of the Creature, which I preserved some time by me. He adds, that he has seen the Creatures alive, and believes they swarm as Bees, on the Sea-Shore, or in the Sea.

The Production
of Coral,
by S. P.
Boccone,
n. 99. p. 6158.

LXX. 1. *S. Boccone* having been present at the *Coral Fishing*, in the Channel of *Messina*, which separates *Calabria* from *Sicily*, relates in a Letter of his, written on that Subject to Signior *Marchetti* at *Pisa*, that before the *Coral Fishers* drew their Nets out of the Water, he immersed his Hand and Arm into the Sea, to feel whether the *Coral* was soft under the Water, before it was drawn up in the Air, and found it altogether hard, except the round

round End, which having been bruised with his Nails, he found it made up of 5 or 6 little Cells, full of a white and somewhat mucilaginous Liquor, resembling that milky Juice, found in Summer in the long Cods of the Herb called *Fluvialis Pistana Foliis Denticulatis*, spoken of by *Joh. Bauhinus*.

This *Coralline Juice* he calls *Leven*, because, having tasted it himself, as well as the Mariners did, they always found it of a sharp and astringent Taste, in such Pieces as they came recently out of the Sea; those that are dried, losing that part of the Taste which is acrimonious, and retaining only that which is astringent: which Change of Taste he affirms to be made in about 6 Hours after the Coral hath been drawn up; in which time also, the said *Leven*, that is inclosed in the Pores is dried, and hath changed its Colour. He inclines strongly to the Opinion of those who conceive, that the long Concoction of the *Ferment* fixes the Parts, and produces the red Colour, especially being near to the hard Coral, and the red *Vermillion*, which surrounds it.

2. *M. Guifony* is of Opinion, that *Coral* is so far from being a Plant, that 'tis a meer *Mineral* composed of much *Salt*, and a little *Earth*; and that 'tis formed into that Substance by a *Precipitation* of divers *Salts*, that ensues upon the Encounter of the *Earth* with those *Salts*; after the manner of the known *Metallick Tree*, which, in a very little time, is form'd, and encreas'd by the Settling and Combination of *Mercury* and *Silver*, dissolved in *Aqua Fortis*, and afterwards cast into common Water; the Parts of this *Mineral* and *Metal* joining themselves one to another. Which thing also happens in some *Subterraneous Grotto's*, where, by a continual and long Fall of Water, drops many sorts of Figures, and amongst them Shapes of little Trees are formed. This Sentiment he confirms, by alledging, that he can shew a *Salt* of *Coral*, which, being cast into Water, and there dissolved, upon the Evaporation of that Water by a gentle Heat, is presently coagulated, and converted into store of small Sticks, resembling a little Forest.

LXXI. 1. The Stones figured like Plants, which *Agricola* calls *Trochitæ*; and the compound ones *Entrochi*; we in *English*, *St. Cutberd's Beads*; are (like the *Lapides Judaici*) of an opaque and dark-coloured Spar; tho I have of them from some Parts of *England*, of a white Spar or Cawke, as our Miners call it. They all break like *Flint*, polished and shining.

Vinegar, as a *Menstruum*, will corrode and dissolve them, (as well as all *Fossils*, of what Figures soever) provided they be broken into different small Grains; and if the Bottom of the Vessel hinder not, they will be moved from Place to Place by it.

The Figure of the *Trochitæ* is cylindrical: the utmost Round or Circle, (we speak of one single Joint, which *Agricola* calls *Trochites*) is in general smooth, both the flat Sides are thick; drawn with fine and small Rays, from a certain Hole in the Middle to the Circumference. Two, three, or more of these *Trochitæ* joined together, make up that other Stone, which is called *Entro-*

By M. Guifony, ib. p. 6159.

Trochitæ & *Entrochi* described by Dr. Lister, n. 100. p. 6181.

chas.

chos. The *Trochita*, or single Joints, are so set together, that the Rays of
 Fig. 93. the one enter into the other Furrows, as in the *Sutures* of the *Skull*.

They are found very plentifully in the *Scars* at *Braughton* and *Stock*, little Villages in *Craven*. I never met with any much above two Inches about; others there are as small as the smallest Pin, and of all *Magnitudes* betwixt those Proportions. They are all broken Bodies; some shorter Pieces, some longer, and some of them indeed *Trochita*, that is, but single Joints. I never found one entire Piece much above 2 Inches long, and that very rarely too; in some of which long Pieces, I have reckoned above 30 Joints. And as they are all broken Bodies, so are they found dejected, and lying confusedly in the Rock; which, in some Places, where they are to be had, is as hard as *Marble*; in other Places, soft and shelly (as they call it) that is, rotten, and perished with the Wet and Air. And though in some Places they are but sprinkled here and there in the Rock, yet there are whole Beds of Rock of vast Extent, which are made up, for the most part, of these, and other figured Stones, as *Bivalve*, *Serpentine*, *Turbinate*, &c. as at *Braughton*.

As to the *Injuries* they have received, in their Removal from the natural Posture, if not Place of their Growth and Formation, they are manifest; for, besides their being all *broken Bodies*, we find many of them depressed and crushed, as if the Joint of a hollow Cane should be trod under foot: These
 Fig. 92. *Crushes* being also real *Cracks*, as of a Stone or Glass. Again, These Stones consisting of many *Vertebra* or Joints, they are many of them strangely *dislocated*; sometimes two, three, or more of the Joints in a Piece are slipped out of order, or rank; and sometimes a whole Series of Joints, as when a Pack of Crown Pieces leans obliquely upon a Table. Further, Others I have, that are twisted like a Cord; if this possibly may be reckoned among the *Injuries*. Lastly, Some have their Joints indeed even, and in *line*; but are yet stuffed with a foreign Matter, as when *Bricks* are laid in *Mortar*.

There is great Variety as to the Thickness of the *Trochita* or single Joints, some are so thin, that they are scarce the full of the 24th Part of an Inch; others are a full quarter of an Inch thick: of these latter I only found at *Stock*. Betwixt these Extremes, there are Joints of all Measures in divers Pieces; but in one and the same Piece, they are mostly of an equal Thickness. And there are slender and small *Entrochi*, or Pieces, which have as thick Joints as the biggest and fairest Pieces.

There is also some Difference in the *Seams*, or closing of the Joints. Some are but seemingly jointed, which appears by this; that if they be eaten down a while in distilled *Vinegar*, the seeming *Sutures* will vanish, as in some I had out of *Staffordshire*, from about *Biresford* upon the *Dove*: Others, and all here at *Braughton* and *Stock*, are really jointed, and the *Sutures* indented; which Indentures being from the terminating of the Rays, they are more fair or large, according to the Difference of the Rays, but even, equal, and regular.

We have said that the utmost Circle is generally flat and smooth, yet are there many other Differences to be noted ; very probably, because they are Parts of different Species.

1. Their Joints are of different Thicknesses.
2. On some *Entrochi*, betwixt Suture and Suture, in the Middle of each Joint, are certain Knots in a Circle ; the Joints thus distinguish'd are very deep and large, and are very frequent at *Stock*.
3. There are likewise of these, with a Circle of Knots, which have many Knots besides on each Joint, and look rugged.
4. Some with much thinner Joints, which yet have a Circle of Knots in the Middle of each Joint ; and this also looks as tho it were all over knotted ; and these are found at *Braughton* only, as far as I know.
5. As some have but one Circle of Knots, others are knotted all over the Joint, and rough ; so are there some others, which have a Circle of larger Knots in the Middle of each Joint, and a Circle of lesser on each side, close adjoining to the Border or Verge of the *Suture*. This is huge pretty, and they are found at *Stock*.
6. Others betwixt *Suture* and *Suture*, in the Middle of each Joint, rise with a circular Edge.
7. A smooth *Entrochos*, with a large or much risen Edge on the Middle of one of the Joints, and a much smaller on the Middle of another Joint, and that alternatively.
8. The same alternate Difference, the Joints only much rounder and blunt, and here the Joints are visibly one thicker than the other.
9. The same, with alternate Edges knotted.
10. A double Edge in the Middle of every Joint : this makes the Joints look as tho they were exceeding thin and numerous, but indeed they are not so.
11. A double Edge in the Middle of every Joint, knotted by Intervals, or, as it were, ferrate Edges.

Some of the Pieces of most, if not all, of the Differences of these *Entrochi*, Fig. 92. are ramous, having less Branches deduced from the greater, and that without Order. These Branches are deep inserted within the Stem, and by being separated, leave great Holes in the Sides of it. The Rays in the Joints of the Branches, run cross to the Rays of the Stem. On thick Stems are sometimes very small Branches, but mostly the bigger the Stem, the thicker the Branches. Some of these Branches are branched again ; yet I find not any of them above one Inch entire, and yet adhering and inserted into its Stock or Bole, and for the most part not above a Joint or two. The Branches are known from the Stem, by being a little crooked, and something tapering or conick. Fig. 93.

We meet but with few Pieces (besides the Branches) that are not exactly cylindrical, setting aside the *Injuries* above-mentioned. And amongst those few, some tapering at both Ends, and much swelled in the Middle ; others figured like a kind of Fruit, or *Lapis Judaicus*, yet truly *Entrochi*, and joint-
ed, Fig. 94.

ed, notwithstanding this Shape: Upon a small Stalk of two or three Joints, is suddenly raised an oval Bottom, broken off also at both Ends.

Fig. 95. To these we shall add, what seems to have been *Summitates*, or *Fastigia*; long and slender Pieces, with a little Button, hollow on the very Top; which Top seems not to have been divided or broken off from any thing else.

These Hollows are sometimes filled with Earth, and sometimes another *Entrochos* is inclosed, like a Pair of Screws; and which is, as it were, Pith to the other.

Fig. 91. Of these inward *Entrochi*, some I have which are transparent. These Hollows or Piths are of different Bores, but most are round: And yet there are of them in great plenty at *Stock*, whose Hollow in the Middle is in the elegant Fashion of a *Cinquefoil*; and the Rays of the Joints of these *Entrochi*, are much deeper and fewer in Number, than of any other yet observed by me. These also are smooth jointed. This is most surprizing, and I know not any Vegetable whose Pith is perforated in such a manner.

Fig. 96, 97, 98. Lastly, We, in these Rocks, find certain rude *Stones* of the Bigness of *Walnuts*, which have many Impressions of *Trochita* upon them, as though they had been the Roots of them. And when these have been a little cleansed in *Vinegar*, these Impressions appear more than casual; for the Substance that covers them (if not the Stones themselves) is Spar, and the Impressions are round Holes with Rays, like those Holes which we said above the Branches made in the Sides of the *Stock*, when broken out from them. I have found some of them most elegantly figured, intire and compleat at *Stock*, amongst very many others strangely shattered and defaced. One is in the Fashion of a *Pine-Apple*, or *Cone*, with a hollow Bottom, about the half of an Inch deep, and as much over at the Bottom: On the very Top is the round Figure of an *Entrochos* broken off; round about the Bottom, or Basis, are five single Feet at equal Distances, in the Figure of Crescents. The Stone is incrustate, or made up of angular Plates, viz. The Bottom is composed of 5 Plates, which we call Feet; the Middle of the Stone of 5 other Plates, all of a *sexangular Figure*; and the Top, Stone. All other Plates are smooth on the out-side.

Another is much after the same pyramidal Fashion; the Bottom Convex, about an Inch and quarter over; on the Top is the lively Impression of an *Entrochos* broken off, or rather a *Trochites* yet remaining; round the Basis are 5 double Points or Feet, at equal Distances, all broken off, and somewhat in the figure of Crescents. This Stone is also incrustate, or covered with *sexangular Plates*, which are rough.

Of these figured Plates, I find great Variety in the Rocks, broken off, and heaped together in great Confusion, which yet manifestly belong to the above-described Stones. Some of the fairest of them, at *Broughton* and *Stock*, are *Pentagonous*, and as broad as my Thumb-Nail, hollow on the side like a Dish; convex on the other side, where are certain eminent Knots about the bigness of a small *Pin's Head*, set in a kind of square Order: This Plate is somewhat thin at the Edges, and yet blunt. Others are *Pentagonous*, and somewhat

what convex above, but not hollow underneath, and without these eminent Knots; the Edges as thin as of a Knife, and sharp. Others of these *Pentagonous* Plates are convex on one side, and somewhat hollow on the other, thick-edged, one of the five Sides only is indented; the indented Side is ever the thinnest, and the Stone is most sloped towards that side. *Note*, That there are many amongst these last indented sorts of Plates, which are channelled on the concave Side, and otherwise notched. One of these *Pentagonous* Plates, from *Wansford-bridge* in *Northamptonshire*, has one of the 5 Sides thick indented; the *convex* Part has in the middle a raised *Umbo*, like some ancient Shields, and round about the Sides a List of smaller *Studs*; and some from *Bugthorp*, under the *Woolds* in *Yorkshire*, are much like this.

The *Sexangular* Plates are small, save here and there one. Some of them are a little hollow on the one Side, and *convex* on the other, having the *convex* Side most elegantly wrought with raised or embossed Work; that is, with an equilateral Triangle besfriding each Corner, and a single right Line in the midst; or, if you will, two Triangles one within another. These we found at *Broughton-Scar* only. Others, which are most common in these Rocks, are a little hollow on the one Side, and *convex* on the other: They are for the most part smooth on the *convex* Side, or scabrous only, some are much thicker than others, some being as thick as broad, but most are Plate-like: the Sides are very unequal, as in *Chrystals*; sometimes five broader Sides, and one very small; again, two Sides broad, and four much narrower, and infinite other Differences as to the Inequality of Sides.

2. 'Tis strange that these main *Stems* should be of equal Bigness from the *By Mr. Ray,* Top to the Bottom, and not at all tapering, if they be indeed the Bodies of *ib. p. 6190.* *Rock-Plants*. There are found in *Malta* certain Stones, called *St. Paul's Batoon*s, which, I suppose, were originally a sort of *Rock-Plants*, like small snagged Sticks, but without any Joints; the Trunks whereof diminish according to the Proportion of other Plants, after the putting forth of their *Bran-*
ches. Those *Roots*, which you have observed, are a good Argument, that these Stones were originally Pieces of *Vegetables*. Who knows but there may be such Bodies growing on the *submarine Rocks* at this day, and that the Fishers for *Coral* may find of them; tho, being of no use, they neglect and cast them away. Certain it is, there is a sort of *Coral* jointed.

3. All the *Trochyta* and *Entrochi*, described by *Dr. Lister*, are found in *Men-* *By Mr. J. Beaumont,*
dip-Hills, except that figured like a Fruit, and my Observations generally *n. 129. p. 724.* agree with his. But I may add, that I find even the Joints of some of those *Entrochi*, which swell in the middle, to be of that Make: So that such an *Entrochos* shews like a Parcel of little Barrels, set one on the other.

Their *Hollows* are of all Bignesses, from a *central Point*, to the taking up of more than a third part of the Stone. Some of these *Entrochi* are so hollow, that there is only a thin Shell left, smooth within and without; others have only a thin Shell left, but with *Screws* within and without, and sometimes both these are one entire Piece, with seeming *Sutures*. Those *Hollows*, like a *Cinqué-foil*, seem most natural to the *Radix*, having 5 hollow Stirts or Feet issuing side-ways from it: And I find in some Pieces of *Radix's*, that a little Furrow passes inwardly from each Foot to the Top of the Stone, with a Ridge on the

outside of it. Besides these, I have a new Species of *Trochites* and *Entrochi*, which has 6 Inlets in the Hollow, as the latter has but 5; but with this Difference, that these Inlets terminate in Angles, so that it is a *sexangular Hollow*, whereas the *Cinquesoil* Inlets are round as the Leaf is, and not pointed, tho I have seen even of these with sharp Angles.

The *Rays*, shooting from a *Center*, must of necessity leave considerable Widenesses betwixt them, as they pass towards the Circumference, according to the Bigness thereof: to fill up those Widenesses, I find that in some, betwixt 2 *Rays* issuing from the *Center*, a third *Ray* rises about half-way on the *Stone* from the *Center*, and shoots to the Circumference. Some have their *Rays* gently widening from the *Center* to the Circumference; some have a *Trunk* rising from the *Center*, which grows forked towards the Circumference; sometimes, betwixt those *Forks*, there rises a little *Ray* near the *Trunk* where the *Forks* join, which shoots to the Circumference; (but, *Note*, that these Differences are scarce discernible, where the *Rays* are fine, but with the help of a *Glass* :) some again are *ramous*, having a *Trunk* rising from the *Center*, with 3, 4, or 5 *Branches* shooting to the Circumference; some are smooth half-way on the *Stone* from the *Center*, and have a *Circle* of small *Rays* near the Circumference; some are smooth without any *Rays*, these are commonly pretty thick, and are joined in an *Entrochos* after this manner: One *Trochite* a little within the outward *Circle*, in the upper and lower Parts, where the *Rays* use to be, has round Inlets or *Sockets*, pretty deep, so that only a thin *Tympanum* hinders, but the *Trochite* would be hollow at this Wideness all thro'; and in the middle of this *Tympanum* there is a *Hole*, as in other *Trochites*, which is sometimes round, sometimes like a *Cinquesoil*: The *Trochites*, that answer this on both sides, have smooth *Joints*, (I cannot properly call them *Screws*, having no *Ridges*) which enter into these *Sockets*; those *Joints* being hollow also, and so other *Trochites*, with *Sockets*, come on upon those again to make up the *Entrochos*. Some of these have both *Sockets* and *Rays*, some have a *Socket* on the one side, and *Rays* on the other without a *Socket*; some are all smooth, only a small *Ridge* runs round them a little within the outward *Circle*, which enters into a small *Furrow* answering to it; some are all smooth, and joined only, *per harmoniam*, as *Dr. Lister* calls it; some *Trochites* hold of an equal *Thickness* of Substance from the *Center* to the Circumference; some are pretty thick in the Circumference, and grow thinner towards the *Center*, so that they have *Concavities* on both sides, to which *Convexities* in other *Trochites* answer; some hold of an equal *Thickness* half-way on the *Stone* from the outward *Circle*, and then grow concave toward the *Center*. I have also found some *Entrochi*, as well as *Trochites*, of an oval Figure, and their *Bore* is also oval; some *Trochites* of this kind have no *Rays*, but are joined together only by one *Ridge*, which passes directly along the middle of the *Stone* the long way, there being a *Furrow* in the other answering to it: these have also a small *Speck* in the middle, making but a very little *Impression* in the *Stone*, and seldom passing thro' it; tho I have of this sort, with indifferent *Holes*, as the other *Trochites*, but such are commonly pointed at the *Ends*, and not carried out with an oval Round as the others. There are some single *Joints*, which are shaped with

with a *double Oval*; that is, the *Oval* in the upper Part of them stands clean contrary to the *Oval* in their lower Part. In some again, the *Ovals* do not stand so extremely opposite to each other; but only the *Oval* in the upper Part of the *Trochite* seems a little wrested from the direct Line of the *Oval* in the lower Part, so that they stand bend-ways to each other, like a *St. Andrew's Cross*: there are *Entrochi* too made up after this manner; and I find most of the *Oval Entrochi* grow crooked and twisted.

I have one perfect *Radix*, without any Impression of a *Trochite* on it; the Top of it, indeed, is a little flat with a Hole in it, but it is withal very smooth without the least sign of a Ray, yet I find another with the Rays there: at the Middle of the broad End, there is another Hole just opposite to this. At the Ends of the 5 *Stirts* or *Feet*, where the *Hollows* should shew themselves, there grows after a very artificial manner, a pretty large Seam of the same Stone just over the Middle of the *Hollow*, from the upper Part of the *Stirt* to the lower Part of it, parting the *Hollow* in the Middle, and covering about a 3d Part of it; not that this *Seam* enters farther into the *Hollow* than the *Mouth* of it, so that the *Hollow* of each *Stirt* presents itself with 2 Eyes: Hence it appears, that those *Stirts* or *Feet* were never longer than they are, and that no Stone ever grew to them. These *Fore-Seams* being very obnoxious to the least Injury, were broken off from *Dr. Lister's*. The Stone is composed of *Triagonal*, *Tetragonal*, *Pentagonal*, and *Hexagonal Plates*. The upper Part of the *Conical End* is wrought round with 6 large *Hexagonal Plates*, and these reach half way the Stone; then follows a second Round, made up of *Pentagonal Plates*, pretty large, and these reach almost to the broad Bottom, which is a little convex: the Bottom itself, and *Feet*, contain *Plates* of all Makes, but most of them are very small. This Stone is in Substance a whitish Opaque *Fluor*, of the same Nature with the *Trochites*; it has outwardly a rusty Coat, and is blueish within, like some *Sea-Shells*. When 'twas first found, 'twas full of a sort of Ash-colour'd gristy Clay, which is the evident material Cause of it, it being found in a Bed of the same. Fig. 96.

I easily pick'd out the Clay with a Needle, so that 'tis now all hollow; the shell-like and sparry Substance being scarce as thick as a Half-Crown. I have one sexangular Plate, whose convex Part has on it a *Star* consisting of 6 emboss'd Rays, which shoot from the Center directly to the middle Part of the Sides betwixt the Angles; and betwixt every two Rays there grows a little *Stud*, after a very elegant manner. Fig. 97.

I find the *Trochites* sticking to *Rake-mold-stones*, and in the Crannies of Rocks, at all Depths from the Grass to 20 Fathoms; and doubtless there are of them deeper: But I find them most plenteously in certain Beds of an ash-colour'd gristy Clay, and particularly at one place, within a Yard or 2 of the Grass. I found here a Fruit with them like a *Lapis Judaicus*, (though somewhat defac'd) if not a Species thereof; it's about the Bigness of an *Acorn*, with *Ridges* and *Furrows* running the long way; it differs from those described by *Dr. Lister*, being rather less in the Middle than at the Ends, and the *Ridges* not knotted or purld. It is in Substance a whitish opaque *Spar*, like the *Trochites*, tho (as *Dr. Lister* says) some *Trochites* are of a dark-coloured Fig. 94.

Spar; and I find some of a white cawky Substance, and some have a *Tincture* of red; but these Differences proceed from the *Clay* of which they are made: for tho an ash Colour be the chief in it, yet there are some Veins of red in it, some of white, some of a light blue, some of a dark blue, &c. which cause these Varieties in the Stones. I find some *Trochites* and *Entrochi* shaped in a *raw Clay*, before they have attained the Consistency of a *Stone*; and these, if laid in the Sun, become light and spongy like a *Pumex*. I took up there a Piece of another strange *Stone*, of the like *sparry Substance*; it is about the bigness of a *Walnut*, hollow, and fill'd with the said *Clay*: it somewhat resembles a *Helmet*, the fore Part of it is smooth, the upper Part, which has a large Ridge in the Middle, is all wrought with little Rings, three at a place, encircled within each other. The *Stone* call'd *Cornu Ammonis*, shap'd like a *Ram's Horn*, is very frequent in this *Clay*; the largest I have is 7 Inches in Length, 4 Inches in compass at the broad End, and $2\frac{1}{2}$ at the small End, the Top being broken off. Tracing its Original, I find some of the first Bud-dings out of it about the Bigness of a young Cock's Spur, and very much like it: I have some in *raw Clay*, and one growing of a white cawky *Stone*. They generally become at last a whitish *Spar*, and some milk-white, as some of the *Trochites* are.

There are of all intermediate Proportions betwixt these two, tho very few of any Bigness are to be found entire, but all broken and imperfect Pieces. And I take the seeming *Summitates* of *Dr. Lister* to be only little Essays of Nature towards the Production of this *Stone*, the Alliance being evidently nearer, than betwixt them and the *Trochites*. The *Texture* of these *Stones* is thus: Some have massy *Spar* in their insides, which takes up three Parts of the *Stone*; then from the sharp Top there grows thin flat Cells, or small Pipes of *Spar*, set edgeways one close to the other, all round the *Stone*, which shoot towards the broad End, and appear outwardly like small *Ridges* or *Seams*: and many of these *Pipes* running down thus after the *Stone*, shew their Hollows, some at one place of it, some at another, and some not till they come to the broad End: And this is the *Texture* of the great *Stone*, which has Rings also, tho somewhat defac'd, running round it, tending likewise in their Growth towards the broad End, as in a *Ram's Horn*. Most of the lesser *Stones* have very little massy *Spar* within them, and some have none; but appear somewhat hollow at the broad End, with *Cells* coming down inwardly from the Top of the *Stone*, resembling those in the *Flowers* of *Coral*, which terminate its *Branches*; and doubtless, if taken from their Beds in a seasonable time, would yield the like *Milky Juice*: for I find in the Cells of some broken Pieces of these *Stones*, an evident *Concretion* of such a milky Juice. And I may here acquaint you, that I have a Piece of *branchy Spar*, which I found at a Mine on these Hills, growing like *Coral*, and terminated with *Buttons* or *Flowers* like it. I find very few of the lesser *Cornua Ammonis*, whose Cells do any way appear, or shew their Hollows outwardly, as in the great *Stone*, whose outward Surface is wholly made up (as I said) of those Cells, or thin flat Pipes, set close the one to the other; many of which shew their *Hollows* at several Places in the *Stone*, whereas the Cells in the smaller ones

ones appear only inwardly, having one Coat outwardly which covers them all; and this Coat in some is smooth, in others it is all wrought with little Rings like the *Helmet-Stone* before-mention'd; and some Out-sides have Ridges or Rings round them, as a Ram's Horn.

These Stones generally move in Vinegar, Juice of Lemons, &c. sending forth Bubbles, as I find *Caruk* will very freely, and most of our *Mineral Stones*. This Motion seems to proceed from the Contest betwixt the *Acid Spirit of Vinegar*, and the *Mineral Salt*; so that the Spirits, by Fermentation breaking forth under the Stone, produce that Effect.

4. After diligent search, I have at last found a Mine, where well near all the *Entrochi*, (so call'd hitherto) or Bodies of *Rock-Plants*, grew tapering and ramous; some of them having Branches issuing from them near two Inches in Length, and other small Branches issuing from those; and upon a nearer Search, I discover'd an entire Plant, though small, growing up after the Side of a Stone. I found also, that all the Cliffs in some Mines, are made up of these *Stone Plants*; whereof some, as appears, were converted into the Nature of those *Limestone Rocks*, whilst they were in their first tender Growth; others being become *Spar*, compose Rocks of that Substance.

Considering that all the Cliffs for a very large Circumference in some Places, are made up of these Plants, we may truly say, that there have been, and are whole Fields or Forests of these in the Earth, as there are of *Coral* in the *Red Sea*. In the *Courses*, (or *Loads* as some call them) betwixt the Cliffs, I find of these *Plants* growing up in the gristy Clay, mentioned above, being rooted on the *Rake-mold Stones*; many of them being above a Foot in Height, and about the Bigness of the Stem of a Tobacco-Pipe: All I have yet seen of this Length, are either raw Clay, or of the Consistency of a *Lime-Stone*; and some of them have outwardly evident Beginnings of *Circles* and *Sutures*. The small *Plant* which is entire, and the *branched Bodies* of many others, have attained their full Term of Growth; being become perfect *Spar*. If these had ever a Height answerable to their Bigness, (some of them being near three Inches about) they must have been much higher than those before-mentioned. The Branches are all jointed, and have the same Bore with the Trunks, and are terminated with round and blunt Joints, but very small. I find the Bores, or Hollows of such as are found to be commonly filled with a milky curdled Substance, which probably, in their Time of Growth, was fluid, like that in *Coral*. As it cannot be doubted but many of these *Plants* grow on those admirable *Radixes*, of which we have given an Account; and whereof I have at present some Pieces, which have a *Cinquefoil Bore* on the Top; others with the Impressions of *Oval Joints* there, and many other Differences: so I am now fully satisfy'd, that many of them grow from *Plain Roots*; that is, from *Plain Spar*, or *Lime-Stone*, without any such Figure, as the entire Plant does, and many other Trunks which I have noted.

These *Plants* do not always grow up with one Trunk or Body, but sometimes 5, or 6 Sprouts, near of an equal Bigness, shoot up together from the same Root, as it usually happens with *Coral*. I have met with some of them which have only four Inlets in their Hollows, and others with seven.

Some

Pl. p. 782.
Fig. 100.

Some have a *circular Edge* on every other Joint, the intermittent Joint being smooth without Edge or Knot. Some Trunks have circular Edges on the middle of every Joint ; but so, that the first and fifth Edges are the highest, the second and fourth the lowest ; the third is higher than the latter, and lower than the former ; the Joints themselves being great and small accordingly, and this Order holds all along the Plant. Some Trunks have Edges according to the same Order, only the Edges on the second and fourth Joints are round and blunt, the other three being sharp ; some have Edges after the same Order, which are all round and blunt. There are some Trunks wrought after the same manner, only the first and fifth Joints have a Circle of Knots round them, the other three have Edges : Some Trunks have no Circles, nor Knots, but are only a little scabrous like the *Plates* which compose some Roots. But notwithstanding these Diversities of *Figures*, the Texture of their Substance appears to be wholly the same : And therefore since we find no Qualities, either by the Smell or Taste, which manifest any specific Distinction ; it may, perhaps, be as hard to make them out to be distinct Species, as to shew a specific Difference betwixt several Snow Blossoms.

Fig. 101. The Reason of that strange Disorder which these *Plants* usually lie in, and of those Injuries they have received, perhaps may be this ; whilst they were growing, the Clay wherein they grew was soft as a Quagmire, these probably requiring such a Substance to support their Growth, as *Coral* does Sea Water. Afterwards as they began to settle to a stony Consistency, and as part of the Clay became of a rocky Nature, the whole Mass sunk from its Position, and the Moisture passing away made some Concavities, washing down some broken Pieces of those Stones with it ; and Lumps of Clay, and other Stones falling down through those Crannies, added to their Confusion, being very apt to be disordered by the least Concussion, either whilst they were in their first Growth, or after they were become *Spar*, their Joints being very tenderly set together : and hence these Stones are generally found in *Leirey* Places (as they call it) that is, *Cavernous*.

These rocky Plants begin their Growth from the finest Parts of Clay, being commonly white, soft, and smooth at first ; and by degrees come to have Ridges, Knots, and Sutures, as they grow towards a stony, and so to a sparry Nature.

The Pith continues still soft and white, as the whole is at first ; and it is continually refreshed by the *Mineral* Steams and Moisture, which have free Access to it through the 5 hollow Stirts or Feet, in the *figur'd Roots*, or through the Mass of Clay which commonly lies under the *plain Roots*. Nor can it be said, but those *Stone-Plants* have true Life and Growth ; for since, in the Curiosity of their Make, they may contend with the greatest Part of the *Vegetable* Kingdom, and are shaped like them, having inward Pith or Sap, and likewise Joints and Runnings in their Grit, and sometimes Cells, which may very well supply the Place of Veins and Fibres ; I know not why they may not be allowed, as proper a *Vegetation* as any Plant whatsoever.

And

And though a Salt of *Coral* after Dissolution, will upon Coagulation shoot ^{vid. Sup.} into a little Grove of Plants, as it were, resembling the Growth of *Coral*, ^{§. LXX. 2.} yet this cannot disprove its *Vegetation*; for it's well known, that all Plants may be so prepared, that from their *Ashes* they will rise again in their proper Species after such a manner.

But I am inclined to the Opinion, that these *Rock Plants* are *Lapides sui generis*, and not *Parts of Plants or Animals Petrefied*. ^{n. 150. p. 276.} Indeed the *Figured Roots* on which these *Rock Plants* sometimes grow (as appears by the Impression of *Rays* on the Tops of some answering to those in the *Joints* of the Plants, and by the Impression of *oval Joints* there) may give us some Suspicion that they once belong'd to an *Animal*, whether it were a Species of the *Stella Arborescens*, or some other: But the *Trunks* of these *Stone-Plants* cannot be looked upon as *Parts of Animals*, with the least shew of Probability. And I think them almost as hardly reducible to any known Species of *Vegetables*; considering that besides the *Bores* of some of these with 4, 5, 6, and 7 Inlets in them, and besides their admirably diversified *Jointings*, scarce either of them to be matched in any *Vegetable*, I have by me above 20, if not 30, Species of these *Rock-Plants*, differing outwardly from each other in their *Joints*, *Knots* and *Sutures*, all observing a wonderful Regularity, and not one of them to be parallel'd by any *Vegetable* that I know of in Nature. And we cannot well imagine, how so many Species, diffused through many parts of the whole Earth, should all happen to be lost together. So that upon the whole, this seems to me a considerable Objection against those who maintain that all figured Stones in the Earth, are *Petrefactions* of Plants or Animals; to which Opinion *Steno*, in his Dissertation concerning Solids naturally contained within Solids, adheres.

LXXII. 1. I have procured a good quantity of the *Astroites* from *Bugthorp* ^{The Astroites, By Dr. Lister. n. 112. p. 274.} and *Leppington* at the Foot of the *Yorkshire Woods*: At the former Place I have seen them dug out of a certain blue Clay on the Banks of a small Rivulet, betwixt the Town and the Foot of the *Woods*. There are plenty of them wash'd into the Brook; but the most fair and solid are those we get out of the Clay. ^{Fig. 103.}

The Matter and Substance of these Stones, if broken, is *Flint-like*, of a dark shining Politure; but much softer, and easily corroded by an *Acid Menstruum*. *Vinegar* indeed makes them creep; but a stronger Spirit, as of *Nitre*, tosses them. I doubt not, but they will readily calcine, as the *Bellemnites*, to a very strong and white Lime.

These Stones (as we now find them) are all *Fragments*; either one single Joint, or 2, 3, or more Joints set together, making a *Pentagonous* or five-sided Column: I have not yet had any Piece much above one Inch long, which consisted of 18 Joints; but I have seen one Piece, somewhat shorter than the former, which had 25 Joints. These last thin-jointed Pieces are quite of a different Make, as to all Circumstances, from the other.

Every Joint consists of 5 Angles, which are either drawn out and sharp, and consequently the sides of Pieces made up of such Joints are deep channel'd; (and this is the condition of some of the thick-jointed Pieces, as well as of all the thin-jointed ones) or the Angles are blunt and round, and

and the Sides plain or very little hollowed. There are as big, and as small Pieces of this sort, as of any other more sharp-angled.

Where the Joints are thin or deep, they are so equally throughout the whole Piece; yet are there some, but very few Pieces, which consist of Joints of unequal thickness. Many of the thick-jointed Pieces have certain Joints a thought broader, or a very little standing out at the Angles, and thereby the Joints are distinguished into certain Conjugations of 2, 3, or more Joints: And these Conjugations are very observable in the thin-jointed Stones, and are marked out with a Set of Wyers.

The thickest Piece, which hath yet come to my hand, is not above one Inch and a half about, and those very rare too: From which Size to that of a small Pin, I have all the intermediate Proportions; and these so exceeding small Pieces are as exactly shaped as the greatest. Most Pieces, if not all, of any considerable length, are not streight, but visibly bent and inclining.

All the Pieces, of any sort, are much of an equal thickness, or but little tapering; yet one of the ends, by reason of the Top-Joint, is visibly the thickest.

This Top-Joint hath 5 blunt Angles, and is not hatched or engraven, or but very faintly, on the outside. Every Joint else of a Piece (save the Top-Joint) is an *Intaglia*, and deeply engraven on both sides alike; and will accordingly serve for a Seal. The middle of each Angle is hollow, and the Edges of the Angles are thick furrowed: The Terminations of these Hatchings are the indented Sutures, by which the Joints are set together; the Ridges of one Joint being alternately let into the Furrows of the other next it. The Hatchings of the flat-sided Pieces are in circular Lines; but of the other two Species, they are straight Lines, or near the matter.

Fig. 104. In the very Center of the 5 Angles, is a small Hole, conspicuous for most Joints. Note also, that in the middle of each Joint, betwixt Angle and Angle, in the very Suture, is another such like small Pin-hole very apparent, if the Stones be first well scoured.

Fig. 105. In the deep-jointed Pieces, just under the Top-Joint above described, are the Vestigia of certain Wyers rather than Branches; and sometimes 2, 3, or more of the Joints of the Wyers yet adhering. These Wyers are ever 5 in Number, viz. One in the middle or hollow Part betwixt Angle and Angle. Again in thin-jointed Pieces there are 5 of these Wyers, or a Set of them inserted into every Conjugation of Joints; so that it were some Representation of the thing, to imagine the Stalk of *Asperula* or *Equisetum*: Also I have seen, but that very rarely, (not in one Piece among 500) a Set of Wyers in the middle of a deep-jointed Piece. One thin-jointed Piece I have by me, where a *Wyer* of 20 Joints and upwards (and how much longer they may be, I know not) lies double within the hollow side, and by that Accident was preserved in its natural Place. Farther, some Lumps of *Quarry* I have from the Place abovenamed, where the Wyers, as well as the Stones themselves, are seen in long Pieces. It is no wonder, that these Wyers are knock'd off, and but very rarely found adhering to the Stones they belong to, being very small and slender, of a round

Fig. 106.

Figure

Figure and smooth-jointed, being set together *per Harmoniam*, and not indented Sutures. Nothing that I can think of, is so like these Wyers, as the *Antenna* of *Libsters*. Lastly, some of these Wyers are knotted, and others of them fairly subdivided or branched.

2. If you can allow the *Trochites* and *Entrochi* to have been Fragments of *Rock-Plants*, I see not why you should make any difficulty of admitting these to have been so too; the several *Internodia* being alike thin in both, and the *Commissures* not much different; only the external Figure doth not correspond. The Wyers springing out of the Furrows or Concave Angles of some of the *Internodia*, and incircling the Stalk like the Leaves of *Asperula* or *Equisetum*, seems to me to argue these Bodies to belong to the Genus of *Vegetables*; no less than *Coral*, *Coralline*, and the several sorts of *Port*, some of which are also jointed: But no *Vegetable* either of Land or Sea, that I know of, hath such frequent Joints and short or thin *Internodia*, and so they are things of their own Kind, whose Species is, for ought we know, lost. If they were *Vegetables*, I guess they were never soft, but grew upon the Rocks like *Coral*, and the other Stone-Plants, just as they are.

The Leaves of some sorts of *Equisetum* are jointed, as well as the Stalk; else I know no Plant that hath jointed Leaves, except some sorts of *Rush-grass*.

I have found on the Banks of the River *Tanar* in *Piedmont*, plenty of the Fragments of the Stalks of *Equisetum* perfectly *Petrefied*, with little or no Increase of Bulk, so exactly like the Plant, that all the *Striae* did all along clearly appear. The colour of these petrefied Stalks was white.

LXXIII. We have plenty of Stones called *Dactyli Idai* and *Lapides Judai* Lapides Judai, by Dr. Lister. n. 110. p. 224. (for Kind) in the Stone-Quarries at *Newton* near *Hemesley* and at *Helling-ley* by *Malton*. There is some variety in the Figure of them; but the most common one in these Rocks is after the fashion of *Date-Stone*, round and long Fig. 107. about an Inch, and sometimes longer. They are a little swell'd in the middle, and narrow towards each end: They are channelled the length way, and upon the Ridge khotted or purled all over with small Knots, set in a *Quincunx* Order. The inward Substance is a white Opaque *Sparr*, and breaks smooth like a *Flint*, not at all hollow in the middle, as are the *Belemnites*.

LXXIV. 1. Dr. *Home* of *Berwick* tells me, that he never used the *Ostracites* to any that he knew to be troubled with a *Confirmed Stone* (being persuaded that no Medicine can break a large Stone) but only to such as were afflicted with *Gravel* or *small Stones*, that some of his Patients were cured without Evacuating any *Gravel* or *Stones* at all, that others evacuated both: That it never does its Work suddenly, (being not remarkably *Diuretick*) but that it rather dissolved the little Stones than forced them. That none that he ever gave this Medicine to, however grievously and frequently afflicted before, have ever been troubled with *Nephritick Pains* since; that his manner of giving it, is in fine Powder mixed with about a third part of *Flores Chamomeli*; Dose from half a Dram to one Dram in White-Wine: That the greatest

Dose is often apt to offend and nauseate the Stomach ; that he once gave it alone with a weak Infusion of *Chamomile Flowers* in White-Wine after it, but this did not so well.

I can say little of my own Knowledge of this Medicine, having had it but a short while, and not used it yet to any but one Gentlewoman, whose frequent and violent Fits of the *Gravel*, made her lead a Life uneasy enough. I gave her this Medicine mixt with powder'd *Semina Saxifrag.* I cannot say, that since she used this Medicine she never had any returns of her Pains, but she neither has them so violent, nor so frequently ; and when ever she is threatned with them, she most certainly finds Ease by that time she has taken 3 Doses of her Powder. And she has, since the use of this Medicine, voided a great many small Stones. But the Reason perhaps why she is still threatned with the return of her *Nephritick Pains*, is, that she has never follow'd her Medicine throughly, but upon the third Dose, finding such certain Ease, she gives it over, till a new Fit forces her to use it again.

I take this Shell to be what Dr. Lister calls *Ostracites Maximus Rugosus & Asper.* It burns to a Lime as other Shells do, and as the *Selenites* (tho' weakly) do. It yields no *Volatile Salt*, tho' I tryed it in a naked Fire ; nor do common Oyster-shells, fresh taken and used, afford above half a Scruple of a Liquor somewhat moderately *Urinous*, from 4 Ounces of Shells. And it may be, if they were long dryed and exposed to the Weather, they would lose even that, and yield no more *Volatile Salt* than the *Ostracites*. I confess I was somewhat surpriz'd at this matter ; since there are who say, that even the other Shells, that are commonly call'd *Petrefy'd*, yield a *Volatile Salt* : and I had my self from the Shells of *Crustaceous Fishes*, (particularly of *Lobsters*) a *Volatile Salt* and a *Fetid Oil* in no inconsiderable Quantity, even in a *Sand Furnace*. But these sort of Shells differ from other Shells (as Dr. Lister has exactly observ'd) in this too, *Quod in his Umbo ad Cardinem leviter rostratus est, qui tamen in Ostreis paulum aliter est.* They differ too in their *Specifick Gravity*, these being more ponderous than common Oyster-shells, and somewhat near the *Specifick Gravity* of the *Selenites*. But indeed they differ one from another in *Gravity*, as well as from other Shells, as they partake more or less of a *Tophaceous Substance* that coats many of them on the inside, and which perhaps may be somewhat a-kin to the *Selenites*. I have observed some such differences among the *Cornua Ammonis*, having had one or two small ones from our Coal-Pits here, that had a considerable Mixture of the *Pyrites* : whereas these that are found about *Whitby*, approach, I think, more to the Nature of the *Alum-Stone* ; and perhaps the *Cornua Ammonis* of the Ancients were found in Beds of somewhat yet more Valuable, since *Pliny* says they were of a Golden Colour, and were reckoned *inter Sacratissimas Aethiopiae Gemmas*. I know *Agricola de Ortu & Causis Subterranean.* Lib. 4. accounts for this Golden Colour, after another manner : *Cornua Ammonis, inquit, succo Aluminis infecta, Aurei coloris fiunt.* And I am ready enough to think there is some Truth not only in this Observation, but in what he immediately adds ; *Idem inquit, & alii quibusdam Lapidibus accidit* : For I cannot but attribute the extraordinary appearance of Colours in

in the *Peacock-Tail Coal*, to its being infected with the *Succus Aluminis*, having seen some Pieces of this pretty sort of Coal shoot into true and genuine *Alum*.

I shall only add, concerning these *Shells*, that if they be *real Shells*, their being found in such different Parts of the World, and at such great distance from any Sea, may serve for a fair and convincing Argument of the Universality of the *Deluge*. And if they be not *Shells*, but only Stones formed by (what some People call) fanciful and sporting Nature, we may, at least, conclude thus much from it; That since even these *Lusus Naturæ*, these Freaks, and random Strokes of Nature, have not only a Beauty, but a real Use, nothing in nature is made in vain: And that many other *Fossils* that we now condemn as Toys and Trifles, fit only for furnishing out a *Museum*, may have other remarkable Virtues, that may, in time, bring even them to be taken notice of, and valued, as well as the long neglected and despised *Ostracites*.

2. The golden Colour is from its being a *Pyrites*, that is, Iron-Stone. Again, ^{By Dr. Lister, ib. p. 85.} all the *Conchitæ* kind, but more particularly the *Belemnitæ* and *Lapides Judaici*, were known to the Ancients for *Specificks* in *Gravel*.

LXXV. *Siliquastrum* (quantum nobis innotuit) toto genere novus est idem-^{Several regularly figured Stones; By Mr. Edw. Lhuyd, n. 100. p. 746.} que rarissimus, nec inelegans Lapis. *Siliquastrum* autem appellare placuit, quod *Siliquæ Lupini* vel alterius cujusdam Leguminis, Valvulum alterum (Cavitate tamen repleta) non parum referat. *Siliquastrum* Notæ Genericæ sunt, quod sit *Lapis figura plerique ad Siliquæ Valvulum (sublato Concarvo) accedenti; ex parte altera semper convexior; & (si Marmoris instar fortuito expositos excipias) minute admodum rigosus, seu, ut explicatius loquar, Crebro & eleganter malleolatus: Facie quasi Oleo obductus, resplendenti: Textura si comminuitur Belemnitis fere ad instar striata. Hujus Lapidis plures dantur Varietates quarum præcipuas solummodo nunc vacat recensere.*

1. *Siliquastrum ad Phaseoli Valvulum quodammodo accedens; seu Siliqua-* Fig. 108.
strum Phaseolatum. Figuram Titulus indicat, Magnitudinem quod attinet; Sescunciali est Longitudine, Dimidium Unciæ Latum, vix Quadrantem crassum. Quoad Peripheriam, aliud Latus quodammodo falcatum est, aliud (quod etiam magis acclive est) rectum: Extremum alterum linea obliqua cum duobus Angulis clausum; alterum non item. Ex parte prona superficies rectilinis striata est, cæterum leviter rugosa; & Color *Anthracinus*, nisi quod ad utrumque Extremum, paululum virescat. Ex parte supina, Accretione quadam Lapidea fœdatur, Coloris *Rubiginosi*. Inveni in Lapidina *Wüneiensis*, septimo ab Urbe *Oxon*. Lapide; sed rarissime occurrit. Triplo aut Quadruplo minores aliquot, in quibusdam à jam descripto differentes, habeo, è fodina *Stunsfeldensi*, in hac Provincia.

2. *Siliquastrum Lupini*, siliquam nonnihil referens; seu veniam dabis sic lo- Fig. 109.
qui, *Siliquastrum Lupinatum.* *Phaseolato* subinde brevior est, at semper latior; Colore incerto, sed ut plurimum a prona parte nigro, vel ad nigredinem accedenti; a supina *rubiginoso*. Sed & utrinque variat quoad Colorem & Superficiem. A parte Gibbosa Lineolis albis & Maculis nescio quibus distinctum vidimus; quod & *Bufoniis* Lapidibus, & *Glossopetris* quibuscunque aliquando

aliquando accidit. Sed & inveni unum aut alterum cui a parte averſa neſcio quid Appendicis adnaſceretur; in qua Virgulæ aliquot Tranſverſæ conſpiciantur, quaſi amiſſi cujuſdam ignoti Veſtigia. Differt hic Lapis a præcedente præcipue, quod ſit latior, magisque reſtus, a neutro latere ſalcatus. In *Anglia Mediterranea* non admodum rarus eſt hic Lapis. Vidimus in *Latemia Garvordienſi* in *Bercheria Witneia* & *Charltonia* apud *Oxonienſes*, ad pagum *Rance* in Comitatu *Northamptonia*, *Honey-Comb-Laſh* apud *Waltonienſes*, &c.

Dantur etiam in hoc genere Lapides, quos *Piſi vulgaris* & *vicia Siliquas* æmulari dixeris.

Fig. 110. 3. *Siliquaſtrum Minus Triangulum*; ſeu *Minus Conchæ* ad inſtar *Roſtellatum*. Colore & Superficie cum reliquis convenit; at *Tellinam* aliquam, vel (mavis) *Conchiam parvam Anglicanam Liſteri*, magis refert quam *Siliquam*. Verum ex facie, cum externa tum interiori, *Siliquaſtrum* ſe prodit. *Stunſfeldia* habuimus in Agro *Oxonienſi*.

Fig. 111. 4. *Siliquaſtrum Officulum* e capite *Aſelli Minoris* referens.

Fig. 112. 5. *Siliquaſtro congener Punctularia Gibboſa*, quandoque *Tortilis*, ſuperficie *Marmorea*; ſeu *Siliquaſtrum Gibboſum*, *Marmoreum*, argute admodum plerique *punctulatum*. Superioribus magis *Terſum* & *Expolitum* eſt hoc *Siliquaſtrum*: ex prona parte nunc magis, nunc minus *Gibboſum*; & Colore ut plurimum *Nigricanti*, alias *Subviridi*, *Exalbido*, &c. Ex parte averſa ſeu interiori, neſcio qua Offea Appendice munitur, Coloris *nigri* vel *rubefcentis*, ſed hoc in plerisque deſideratur. Utrinque in *Mucronem* magis obtuſum deſinit quam priora. In multis que videre contigit Exemplaribus, pars *Gibboſa* Soli obverſa, minutula admodum & creberrima oſtendit *Punctula*. Paſſim occurrit in Comitatu *Bereheriano* & *Oxonienſi*. Inveni in *Lapicidinis* ad pagos *Marcham*, *Garvord* & *Stunſfeld*.

Fig. 113. 6. Ejuſdem Lapidis major Varietas.

Fig. 114. 7. *Siliquaſtro accedens Ricinus*; ſeu *Siliquaſtrum minimum inſtar Seminis Phaſeoli*, *Ricinus Lapis Siliquaſtrum* eſt omnium, quotquot hætenus videre contigit, minimum; quod *Ricini Herbz*, vel etiam *Phaſeoli* cujuſdam minoris Semen quadantenus exprimat. Superne ſcaber eſt, plane ut *Siliquaſtra* proprie ſic dicta; Colore aut *Fuſco* aut *Atro-nitenti*. Infra vero decolor eſt & informis. *Witneia* inveni, inſtar *Scarabæi Atro-nitentes*; *Stunſfeldia* autem, & *Atro-nitentes* & *Fuſcos*.

Conjicio quod hos Lapides quos nos *Siliquaſtra* diximus, poſteri ad minimum (ſi non hujus ſeculi Philoſophi) *Piſcium Dentes* & *Officula*, tuto appellerint. Certe quod ad *Siliquaſtrum minus Triangulum* attinet, vidimus aliquot Specimina, *Officulis* iſtis vulgo notis ex *Aſellorum Capitibus* non parum eoſimilia.

Fig. 115. 8. *Bufonites Majuſculus Atro-rubens inſtar Capſula Glandis Quercina*. Colore eſt undiquaque ex *Atro-subrubente*; quoad cætera omnino convenit cum *Figura Boetii*. Inveni in *Lapicidina Earingdonenſi* apud *Bercherianos*; ſed rarius occurrit.

9. *Bufonites Medius Rotularis* alveolo utrinque donatus. Color in ambitu Fig. 116. subpallidus est; alveolus ab utraque parte rubiginosus. Cum priore habuimus.

10. *Bufonites Medius Orbiculatus*, seu *Bufonites vulgatiore Anglicus*. Majus Fig. 117. culo Atro-rubenti triplo aut quadruplo minor est. Colore insigniter variat; alias *Anthracino*, alias *Fusco*, sive *Hepatico*, alias alio: Sed & nonnunquam *Caruleis* maculis, & lineolis notatum vidimus. Unicum habeo crassiusculum, & cæteris minus depressum, Colore pallido aut exalbido; *Atro Limbo* aut *Fasciola fimbriatum*.

In latomiis & salubetis *Anglia Mediterranea*, passim obviam habuimus: at Specimen novissime dictum, in *Lapidina Faringdonensi*. Passim inveniuntur & minores & minimi orbiculati, & Forma quasi in plano ovata.

11. *Bufonites minimus a convexiori parte rugosus*. In Agro *Glocestrensi* & *Oxonien* Fig. 118. si cum reliquis, sed rarius.

12. *Bufonites Minor, Trochili ad instar Fastigiatus*, seu *Bufonites Trochilus* Fig. 119. dictus. Coloris est ex *Anthracino Subcærulei*, & *Fimbria nigra* donatus; è sabuleto *Faringdonensi*.

13. *Bufonites Minimus Trochilo affinis Calyculo Striato longiculo donatus*. Caly- Fig. 120. culus striatus Castanei Coloris est: Umbonis idem fere Color ac præcedentis. In Sabuleto *Faringdonensi* aliquoties observavimus.

14. *Bufonites Scaphoides extremo altero latiore*. In *Lapidinis Marchamie* & Fig. 121. *Garvordie*, & ad *Faringdoniam* non admodum rarus.

Omnes *Bufonites* ut id semel dicam, variant Colore; at *Anglicani* ut plurimum ad nigrum *Fusum*, & *Hepatiem* accedunt. Hos Lapidem *Anglia* ante hac inveniri non constat: Nam *Bufonites D. Plot*, in *Historia Oxoniensi*, hujus loci non est, *Bufonites D. Christopheri Meret* (si locum memini) Lapidem non erant, sed ipsissimi *Lupi Piscis Dentes*, &c. Quod quidem satis feliciter, sive ab ipso, sive a quovis alio excogitatum: Quippe hi Lapidem aliud non sunt, me Judice, quam *Luporum* aliorumque *Piscium Dentes*, habitu & vestitu Lapidum personati. In fodina *Garvordien* septimo ab *Academia* milliari, (ob rariores quos habet Lapidem, diutius a me frequentata) tandem incidi in *Maxilla* Fig. 122. *Piscis* ut videtur fragmentum, cui tres *Bufonites*, triangulato quodam ordine, arte inhærebant: Bini scilicet orbiculati minores, & minimus tertius. Sed de *Bufonitibus* hæc dicta sufficiant; quos si id magis placeat, *Ichthyodontes Scutellatos* in posterum jure merito appellare poteris.

15. *Plectronites levis Mucrone paulo acutiore*. *Plectronites* non aliud est quam Fig. 123. *Ichthyodos* quidam teretiformis, plectrum Gallinaceum referens radice *Bufonitis* instar, excavata. Colore, Superficie, & Magnitudine, ut reliqui, *Ichthyodontes* variant. Passim in *Lapidinis Bercherianis*, cum *Bufonitibus* & *Glossopetris* inveniuntur: Striato periosteo denudatos suspicor quotquot *Marmoris* ad instar politos cernimus.

16. *Plectronites Major altiuscule Striatus, Mucrone magis obtuso*. Hujus Fig. 124. Lapidis non nisi duo exemplaria hætenus videre contigit. E Fodina *Strunsfeldien*.

17. *Rhombus Minor, sive Medius*, quem *Rhombum* appellare placuit; com- Fig. 125. pressior est quidam Lapis; præter, propter *Cucumerini Seminis* magnitudine, forma.

forma ad Rhomboidem accedenti. Ab uno latere convexior est, & Colore ut plurimum nigro; ex altero planior & testacea quadam lamella obductus; quæ mire splendet, Colore Anthracino vel ex Atro-rubenti, hæc Testula, sive testacea Lamella, Figuram Rhomboidalem constituit margine quandoque leviter inclinato; & quod materiæ Elegantiam, elimatum Testudinis Exuvium quam proxime similat. Invenimus in Lapidinis Marchamensibus & Charletoniæ. Dantur etiam & majores & minimi, & quidam Figura a Rhomboidali multum discrepantes, Rhombum quoad Materiæ & Coloris elegantiam excipit.

Fig. 126. 18. *Scalpellus*. Est autem *Scalpellus*, Lapis Figura ab omnibus hujusque notis prorsus aliena. Quod ad Magnitudinem spectat & Colorem, cum Rhombo aliquatenus convenit. At Figura est omnino sibi propria. *Scalpellum* nominare volui, quoniam *Cutelli* Mucronem quodammodo mentitur. Nam lamellatus est Lapillus, Figura tamen Trigonalis, cum alio quodam Angulo minus eminenti. Facies altera omnino plana est & sessilis; sed altera ob demissum Marginem, seu mavis transversas quasdam Lineas eminentes, undiquaque leviter acclivis. *Charltoniæ* habui cum priore.

Fig. 127. 19. *Bufoniti Congener Gibbus Lapis*: seu *Bufonites Gibbus* cognominatus. *Gibbus* autem Lapis ex re nomen habet; nam *Bufonites* est non ut reliqui plane sessilis, sed omnino arcuatus: adeo ut si in plano posueris, lucem subtus recipiat. Atque hinc a Dorso elatiori, apud nos *Gibbi* nomen sortitus est. In parte *Gibbosa*, foramen obtinet at Basin latiore; ei prorsus simile quo cæteri donantur *Bufonites* minores. In arenosis Marchamiæ Lapidinis invenit optimæ spei Juvenis D. *Johannes Archer*, e Collegio Reginensi: qui inter alios Lapides aliquam multos, ejusdem duo vel tria habet Specimina. Nos postea in sabuleto *Faringdonensi* observavimus.

Hactenus dictos Lapides ut & alios aliquam multos, quos in *Anglia Mediterranea* inveni, pro Piscium Dentibus aliisque Capitulorum Officulis aut habeo, aut vehementer suspicor. Cæterum & eorundem vertebrae non paucas undiquaque in Agris *Glocestriæ*, *Bercheriæ*, & *Oxonii* sparsas, observare licuit; quos omnes generali nomine.

Fig. 128. 20. *Ichthyospondylos* appellare consuevimus. Sunt autem ii vario pro conditione loci tincti; alii nigri, fusci alii, quidam sublutei aut cinerei. Magnitudine etiam & Forma non minus varia sunt quam *Ichthyostea*, superius dicta. Invenimus qui Latrunculos Luforios Magnitudine exsuperent; atque etiam vicæ Semine minores. In arenosis Fodinis Marchamensibus, sine ulla fere (ut mihi visum est) Materiæ Ossæ jactura conservatos vidimus. Porro *Ichthyospondyli* aut raro aut nunquam inveniuntur pluribus simul junctis, ut Piscium Vertebrae; magno quidem Indicio, me Judice, has non esse Lapides spontaneos, ad Imaginem (cognatæ quantumvis Materiæ) Ossium formatos. Nam si Natura subterranea, quod Marina perficit, præstare conatur quidni eodem Opere ac Labore, quo Singularem Piscis Vertebrae, integrum saltem Sceletum, ut cætera nequeat, conficeret.

Fig. 129. 21. *Maxillæ Piscis* Fragmentum Lapideum, cum adnatis *Bufonitibus*, *Garvordiæ* inventum.

22. *Glossopetra*

22. *Glossopetra exigua* cum *Mandibula* fragmento Lapideo adnato. Fa-Fig. 129. ringdon.

23, 24, 25, We found near *Lhan Deilo* in *Caermarthenshire*, 26, 27, 28, ^{n. 243. p. 279.} 29, on the *Severn Shore* in *Glocestershire*; 30, at *Gold Cliff* in *Monmouthshire*, ^{Fig. 130, 131, 132.} and all the rest in the *Isle of Caldey* in *Pembrokeshire*. The 25th, ^{Fig. 133, 134, 135, 136.} whereof we found great Plenty, must doubtless be referred to the *Skeleton* ^{Fig. 137.} of some flat Fish; the 23, and 24, I know not at all what to make of: ^{Fig. 138, 139.} The rest are *Modioli*, or *Vertebrae* of Sea-Stars, for I have been long since ^{140, 141, 142, 143, 144, 145, 146, 147, 148.} fully satisfied, that all sorts of *Entrochi* and *Asteria* must be referred thither; not that I conclude that either these, or any other marine terrestrial Bodies, were ever really either Parts or *Exuvia* of Animals; but that they bear the same Relation to the Sea-Stars, that *Glossopetra* do to the Teeth of Sharks; the Fossil-Shells to the Marine ones, &c.

Fig. 149, 150. Represent a *Lime-Stone Marble*, we have lately discover'd in ^{n. 253. p. 187.} *Wales* when polish'd. We have plenty of it, but few Pieces exceed 6, 9, ^{Fig. 149, 150.} or 12 Inches Diameter, for 'tis only a sort of *Alcyonium*, incorporated in several small Blocks of the *Lime-Stone*, whereof Fig. 149. represents a Piece polish'd perpendicularly, and Fig. 150. horizontally. 'Tis to me more beautiful than the *Florentine Marble*, but much more hard and substantial.

N. B. This Stone is a sort of Coral, and the *Lapidis Astroididis* five *Stella-* ^{By Dr. Sloan.} *vis primum Genus. Boet. de Bodt*; or *Astroites. Worm. Mus.* It grows in the ^{ib. p. 188.} Seas adjoining to *Jamaica*. It is frequently found Fossil in *England*. I have some of it that will polish as well as *Agat*, which was many Years since found out by Mr. *Beaumont*.

LXXVI. 1. This Description of the *Giant's Causway*, I received from a ^{The Giant's} Scholar and a Traveller, who went on purpose the last Summer 1692, with ^{Causway in} the Bishop of *Derry* to see it. It is in the County of *Aurim*, about 7 Miles ^{Ireland, by} East of *Colrain*, and 31 Miles to the East of the Mouth of the River *Derry*. ^{Sir R. Buck-} The Coast there is a very great height from the Sea: And from the Foot ^{ley. n. 199.} of the Precipice, there runs out Northward into the main Ocean, a raised ^{p. 708.} *Causway* of about 80 Foot broad, and about 20 Foot high above the rest of the Strand; its Sides are perpendicular, it was about 200 Foot in view to the Sea-Water.

This whole *Causway* consists all of Pillars. of *Perpendicular Cylinders*, *Hexagons* and *Pentagons*, of about 18 and 20 Inches Diameter, but so justly shot one by another, that not any thing thicker than a Knife will enter between the sides of the Pillars. When one walks upon the Sand below it, the side of this *Causway* has its Face all in *Angles*, the several Cylinders (pardon the Impropriety of the Word) having some two, some three of their Sides open to View. The very vast high Precipice does also consist of Cylinders; tho' some shorter and some longer: And all the Stones that one sees on that Coast, whether single or in Clusters; or that rise up any where out of the Sand, are all *Cylinders*, tho' of ever so different Angles; for there are also Four-Squared upon the same Shore.

By Dr. Sam.
Foley, M.
212. p. 170.

2. The *Giant's Causway* is somewhat more than 3 *English Miles North-East* from the Town of *Colrain*, and about 3 from the *Busb Mills*, almost directly North. It runs from the bottom of an high Hill into the Sea, no Man can tell how far, but at *Low-Water* the Length of it is about 600 *Foot*, and the Breadth of it, in the broadest Place 240 *Foot*, in the narrowest 120 *Foot*. It is very unequal likewise in the Height, in some Places it is about 36 *Foot* high from the Level of the Strand, and in other Places about 15 *Foot*.

It consists of many thousand Pillars, which stand most of them perpendicular to the Plain of the Horizon close to one another, but we could not discern whether they do run down under ground like a *Quarry* or no. Some of them are very long and higher than the rest, others short and broke; some for a pretty large space of an equal Height, so that their Tops make an even plain Surface, many of them imperfect, crack'd and irregular, others entire, uniform and handsome, and these of different shapes and sizes. We found them almost all *Pentagonal* or *Hexagonal*, only we observed that a few had 7 sides, and many more *Pentagons* than *Hexagons*, but they were all irregular: For none that we could observe had their sides of equal Breadth; the Pillars are some of them 15, some 18 Inches, some 2 *Foot* in Diameter, none of them are one entire Stone, but every Pillar consists of several Joints or Pieces, as we may call them, of which some are 6, some 12, some 18 Inches, some 2 *Foot* deep.

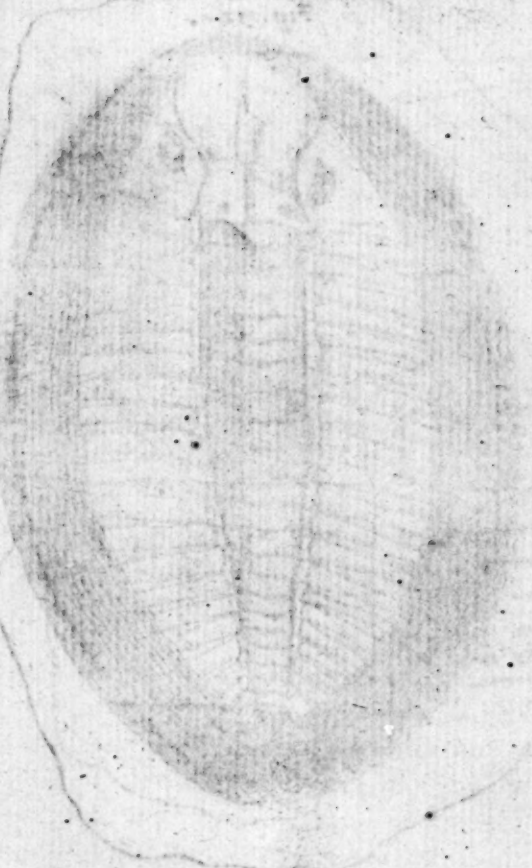
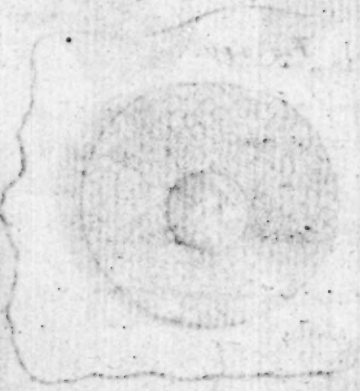
These Pieces lie as close upon one another as 'tis possible for one Stone to lie upon another; not jointing with flat Surfaces, for when you force one off the other, one of them is always Concave in the middle, the other Convex. There are many of these kind of Joints, which lie loose upon some part of the *Causway*, and on the Strand, which were blown or washed off the Pillars. These Joints are not always placed alike, for in some Pillars the *Convexity* is always upwards, and in others it stands always downwards. When you force them asunder, both the *Concave* and *Convex* Superficies are very smooth, as are also the sides of the Pillars which touch one another, being of a *whitish Free-Stone* Colour, but a finer closer Grit; whereas when we broke some Pieces off them, the Inside appeared like dark *Marble*.

The Pillars stand very close to one another, and tho' some have 5 Sides, and others of them 6, yet the Contextures of them are so adapted, that there is no Vacuity between them; the Inequality of the Numbers of the sides of the Pillars, being often in a very surprizing and a wonderful Manner, throughout the whole *Causway*, compensated by the Inequality of the Breadths and Angles of those Sides: so that the whole at a little distance looks very Regular, and every single Pillar does retain its own Thickness, and Angles and Sides, from Top to Bottom.

Those Pillars which seem to be entire as they were originally, are at the Top flat and rough, without any Graving or *Striate* Lines; those which lie low to the Sea, are washed smooth; and others that seem to have their natural Tops blown or washed off, are some concave, and others convex.

The high Bank hanging over the *Causway* on that side which lies next it, and towards the Sea, seems to be for the most part composed of the common
sort

Plate 6.



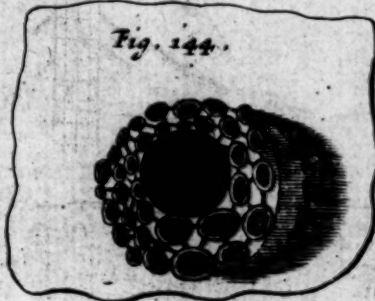
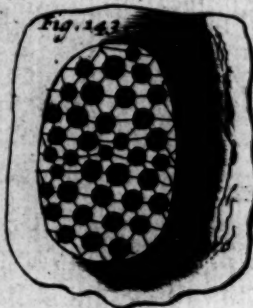
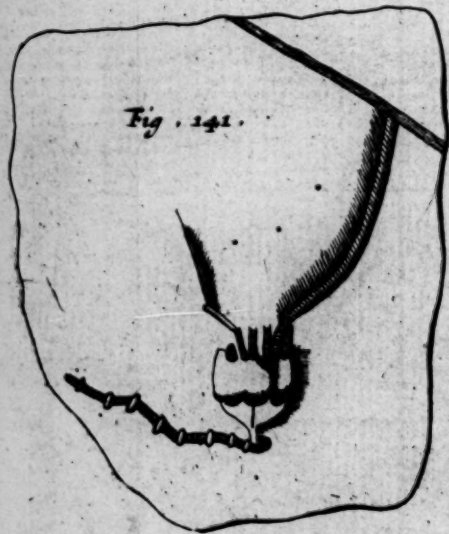
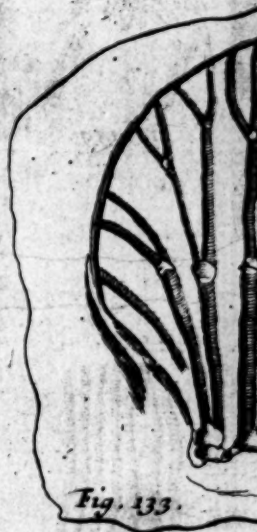
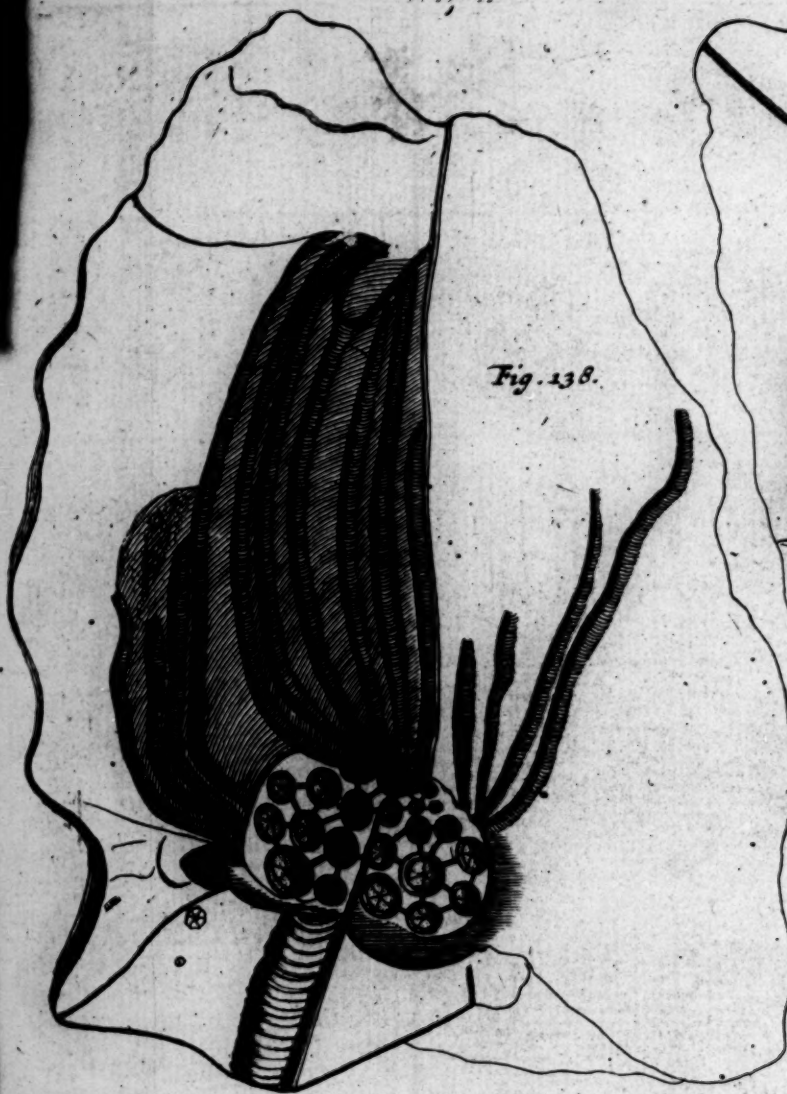


Fig. 130.



Fig. 131.



Fig. 145.



Plate 6. Vol. 2. Pag. 512.

Fig. 136.



Fig. 134.

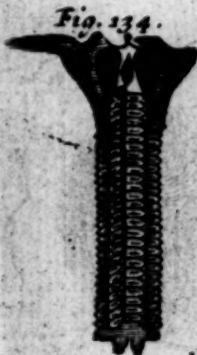


Fig. 146.



Fig. 148.



Fig. 132.

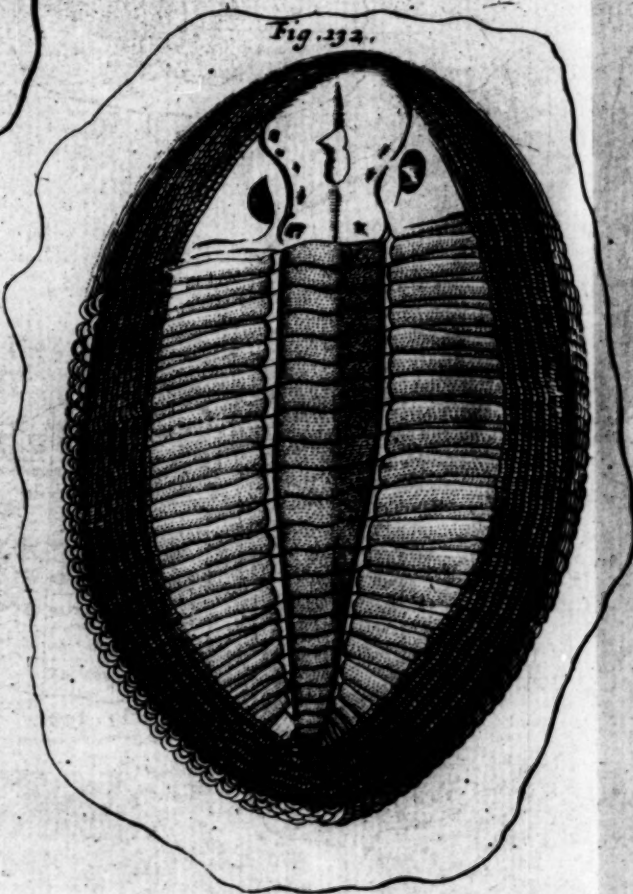
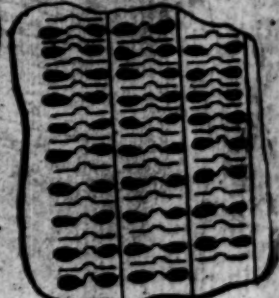
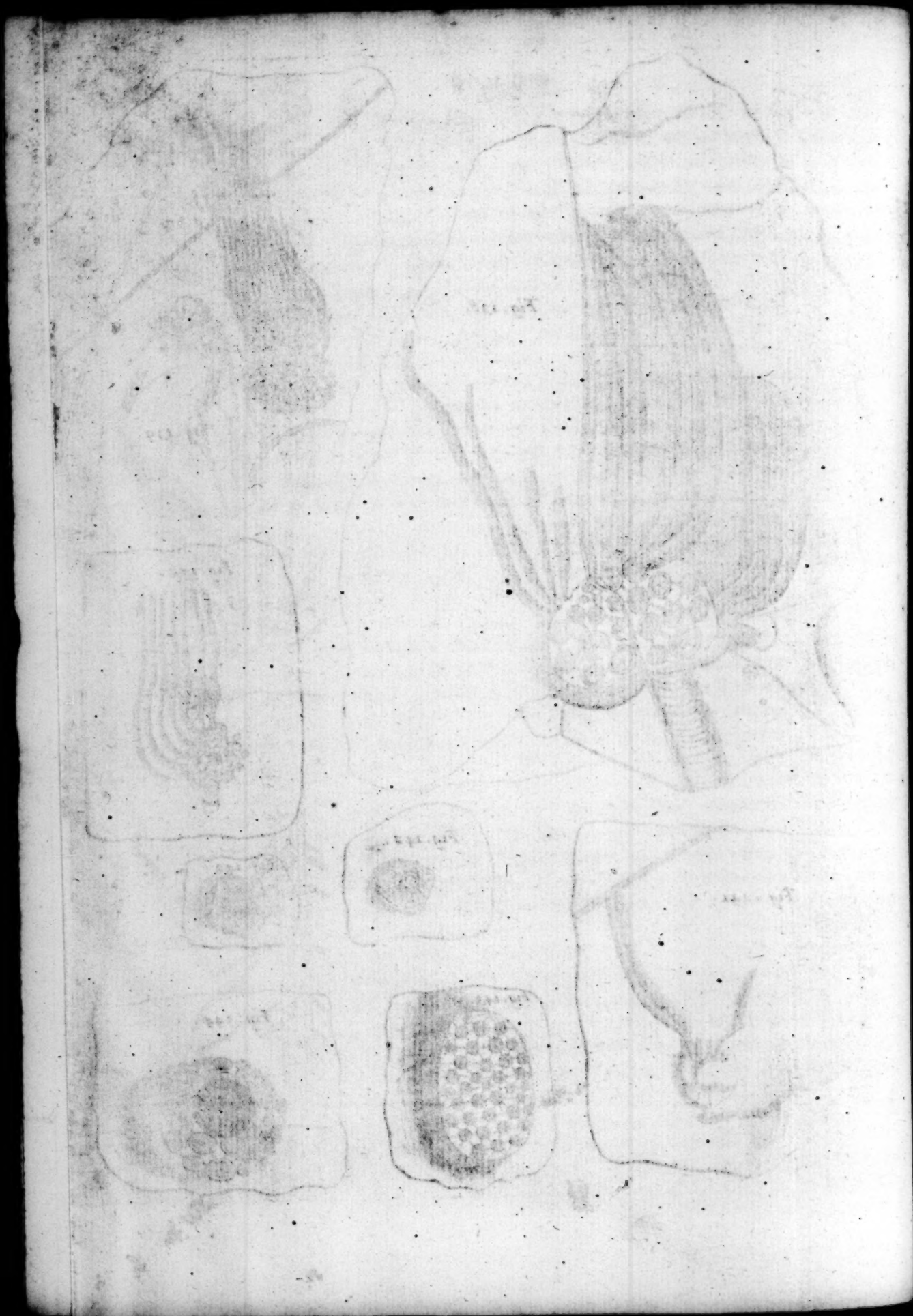


Fig. 147.



Fig. 135.





fort of Craggy Rock only we saw a few irregular Pillars on the East-Side, and some farther on the North, which they call the *Looms*, or *Organs*, standing in the side of a Hill; the Pillars in the middle being the longest, and those on each side of them still shorter and shorter: But just over the *Causway*, we saw as it were the Tops of some Pillars appearing out of the sides of the Hill, not standing, nor lying flat, but sloping.

We suppose each Pillar, throughout the *Causway*, to continue the same to the very bottom, because all that we saw on the Sides were so.

N. B. The several sides of one and the same Pillar are as in the Planes of *Crystals*, of very unequal breadths or lengths, call it either, when you measure them Horizontally; and that in such as are *Hexagonal* a broader Side always subtends, or is opposite to, a narrower, which sort of Geometry Nature likewise observes in the Formation of *Crystals*. ib. p. 174.

3. Among the several *Figur'd Stones* already described by Authors, I find none that has more Agreement with those which compose our *Giant's Causway* than the *Entrochos*, the *Astroites* or *Lapis Stellaris*, and the *Lapis Basanus* or *Basaltus*: And yet for all the great Resemblance they have in some Particulars, they differ very much in others. By Dr. Tho. Molyneux. ib. p. 175.

The *Entrochos* agrees with the *Pillars* of our *Causway* in that it is a stony Substance, formed by Nature *Column-wise*, and consisting of 20 or 30 several *Internodia*, or *Joints*, set one a-top of another; but then it differs in that its outward Shape is round and *Cylindrical*; in its having a *Hole*, or *Pith*, run from top to bottom through all the *Joints*; in the setting on, or way of fitting one Joint to another; and in its Size and Magnitude.

The *Astroites* or *Lapis Stellaris* is not only shap'd *Column-wise*, as the *Entrochos*, and jointed with several *Internodia* closely adjusted to one another, but its Sides are *Angular*. But then it must be observed that the Sides of the *Astroites* are always *fulcated* or a little furrowed, and are constantly *Pentagons*; whereas the *Irish-Stone* has its Sides perfectly smooth, and *plane*, and sometimes in *Hexagons* and *Heptagons* as well as *Pentagons*. Moreover the *Astroites* has Furrow'd and Protuberant Rays striking from its Center, somewhat as they draw a Star, whence it has its Name; that adapting the *Concavities* and *Convexities* together, cause the Cohesion of the *Joints* to one another: whereas the Internal Superficies of the *Internodia* in our *Irish-Stone* sends forth no sort of Rays from its Center, and unite to one another by a quite different *Articulation*. For besides what Dr. *Foley* remarks of the bottom or top of each Joint, having a large round *Concavity* or *Convexity* that extends it self from the Center of the Stone within an Inch or two of the Angular Circumference; examining two *Joints* that were sent up from the Place hither to *Dublin*, I observed likewise, that the bottom or top of each Joint round this *Concavity* or *Convexity* either rises with an eminent *Verge*, or *Ridge*, if it be *Concave* in the Middle, or if it be *Convex*, is hollowed with such a sort of Groove, as to receive closely into it all the eminent Ridge of the next Joint either above or below it: so that each Superficies in the *Articulations* adapt themselves on all sides so exactly one to the other,

as 'tis possible for two Bodies, that are only Contiguous and not Cohering.

The *Astroites* also, as well as the *Entrochos*, differs extremely from our Stone in its *Size*, or *Magnitude*; for the largest that is found of either of those kinds, do not much exceed the thickness of a Man's Thumb, whereas our *Columns* are some of them two Foot in Diameter. Yet this disproportion of Bulk is not so considerable a difference, since we observe that Nature affects the like Disparity in other of her Works, and those too nearly allied, and evidently of the same Tribe, or Family. Our small *Jointed Rushes* or *Reeds*, and the largest *East Indian Bambou*, one of which I remember to have seen in *Holland* above 26 Foot high, and as thick as a Man's Middle, are yet Plants of the same Species and Class.

But nothing among all the *Fossil* Tribe that I have seen or read of, comes so nigh in all respects in its Formation, Substance, Size, Way of growth or Manner of standing, &c. to the *Columns* whereof this *Causway* is composed, as the *Lapis Basaltis Misneus*, described by *Kentmannus* in *Gesner de Figuris Lapidum*, whereof he says there is a great large Bed within three Miles of *Dresden* in *Saxony*. He gives the following Account of it thus in his own words.——*Lapides Angulosi plures coagmentati Basaltis representat, qui crescit forma & magnitudine Fici mediocris, Singularis quidem sed Copiosus atque ita Functus Coaptatusque, veluti ab Arculario arte commissus esset; septem, sex, quinque, nonnunquam sed rarius quatuor Angulorum: Omnino Figura Trabis erecta, foris Levis, & Tactu minime Asper, Ferrugineus, Ponderosus, Duritie velut Adamantis; Hi Lapides sic Coagmentati à terra Ulnas decem & septem extant; quanto spatio intra Terram condantur, nemini adhuc exploratum est.* But, I find this difference between these and the *Misnean Basaltis*, that its *Columns* were one entire Piece from top to bottom, whereas our *Irish Basaltis*, is composed of *Columns* divided into many Joints. So that I think it may not improperly be called, to distinguish it from this and all other *Fossils*; *Lapis Basaltis vel Basanos Maximus Hibernicus Angulis minimum Tribus, plurimum Octo constans; crebris Articulis sibi invicem affabre conjunctis, sed facile separabilibus, Geniculatus.*

Whether our *Irish Basaltis* can pretend to the Name *Basanos*, on the same account the *Misnean* does, from the Greek word *Βασανίζω*, *Exploro*, because it has the property of the *Touch-Stone*, that shews by Lines drawn with Metals on its smooth Surface, which are Genuine, and which Adulterate, I cannot positively say; because those Pieces I have, are so rough, that unless some part of the Superficies were artificially polished, the Experiment cannot be made: Yet I have reason to believe it would succeed, were the Stone polished; because I find *Black Marble* in general, so it be of a close Texture and hard, as this is, always partakes of that property.

4. To have a just Idea of this wonderful Production, I proposed the last Summer 1697, to some Philosophical Gentlemen here in *Dublin*, that we should employ, at our common Charge, one Mr. *Sandys*, a good Master in designing and drawing Prospects, to go into the North of *Ireland*, and upon the Place take the genuine and accurate Figure of the whole Rock, with the natural Posture of the Hills and Country about it for some

A farther Account of the Giant's Causway; by Dr. Tho. Molineux, n. 235. and n. 241. p. 209.

some distance. Accordingly we sent him away with such Instructions as I drew up for him, and he returned soon after with a fair and beautiful Draught very expressive of each Particular we desired.

A. The *Great Causway*, which is from B. to C. 135 Yards, from D. to E. 120 Yards, and from F. to G. 64 Yards.

H. The *Imperfect Causway*, which is 120 Yards long.

Fig. 151.

I. Stones, the same as those of the *Causway*, which lie on their sides in the Hill.

K. Rocks in the Sea, which appear to be the same sort of Stone.

L. The *Organs*, which are *Pillars*, the same with the *Causway*.

M. The *Chimneys*, which are Stone and make that Figure.

The *Prick'd Line* in the *Causway*, shews how far the Sea flows at High-Water.

Fig. 152. The Prospect of the East-Side of the *Causway*.

Fig. 152.

There are also several of these kind of Stones seen in the sides of the Rocks.

But the most instructive part of the Scheme is that which expresses all the *various Figures* of the several *Joints* and *Columns* that have been found by careful Observation to make up the *Causway*.

N. A Joint but of 3 Sides.

O. A Joint of 4 Sides.

P. A Joint of 5 Sides.

Q. A Joint of 6 Sides.

R. A Joint of 7 Sides.

S. A Joint of 8 Sides.

Fig. 153.

Fig. 154. A piece of a *Column* of 6 Sides, transversly divided in the middle, the uppermost part *a*. laid close by the lower part *b*. that the Manner may the better and more plainly appear, how the *Convexity* or *Rising* of the Joint below, mark'd *c*. was let into the hollow of the Joint above, mark'd *d*. when that was in its native Posture, standing a-top and covering it. By this sort of *Articulation* the several *Joints* of the *Columns*, whether they consist of 3, 4, 5, 6, 7, or 8 Sides, adapt and unite themselves to one another; and observe in all the rest of the Figures, *c*. denotes a *Convexity* or *Rising*; *d*. a *Cavity* or *Hollowness*, in the Stone.

Fig. 155. Is a Collection of 7 *Columns* as they stand together in the *Causway*; Fig. 155. and shew that though the *Pillars* differ from one another in their *Shape* and *Angles*, yet they adjust their Sides in such a manner to the next immediate adjoining *Columns*, that there remains no *Vacuity* between them: For the *Pillars* are of such various Figures, that all sort of Interstices, of what shape soever, are entirely fill'd up by one or other of them. e e e e the sides of the *Pillars*, which shew by their outward Surface that each *Column* consists of many *Joints* placed one above another, from top to bottom; and these *Joints* so closely contiguous, that only a small *Crevise* or *Line* seems to sever them; some with their *Convexities* uppermost, as those mark'd *c*. others with their *Concavities*, as those mark'd *d*.

The *Triangular*, *Quadrangular*, and *Octangular Pillars* are much fewer in Number than those other *Figur'd Columns*: So that they do not come readily in sight, except they be carefully searched after.

But this sort of Stone is not more remarkable for being cut thus naturally into *Regular Geometrical Figures*, than for being found in such plenty and vast abundance in many parts of this Country, for 4 or 5 Miles about. For besides what goes under the vulgar Name of the *Giant's Causway*, which it self alone is of a great Extent, and how far it may run into the Sea none can tell, there are many other Collections of the same kind of *Pillars*, situated in and about this Place; as two lesser but more imperfect and broken *Causways* as we may call them, that both lie at some distance on the left Hand of the great one, as you face the North; and a little farther into the Sea some Rocks shew themselves above Water, when the Tide is low, that seem all made still of the same Stone. And if you ascend towards the Land in the Hill above the *Causway* next and immediately adjoining to it, you meet with more of the same sort of *Pillars*, but in a different Situation, not perpendicular and erect, but lying as 'twere on their Sides in a slanting Posture.

Beyond this Hill Eastward, at several distances, stand many Sets of straight and upright Columns ranged in curious Order along the sides of the Hills: That Parcel of them which is most conspicuous and nearest the *Causway*, the Country People call the *Looms* or *Organs*, from its formal Shape; which is so very regular, that all its several *Pillars* may be distinctly counted, and they are just 50 in Number; the largest and tallest, at least 40 Foot high, consists of 44 distinct Joints, and stands directly in the middle of all the rest, they gradually decreasing in length on both sides of it, like *Organ Pipes*.

Four Miles Westward of the *Giant's Causway*, a Mile and a half distant from the Sea, three Miles from the Town of *Coleraine*, and about two from *Dunluce*, an old Seat of the Marquiss of *Antrim*, several Ranges of tall Pillars shew themselves, along the side of a Rock, for about 300 Paces together; a Church within a quarter of a Mile of them call'd *Balliwillan Church*, I am told, was built for the most part with Stone taken from those Pillars, which are all of the same sort of Stone with the Columns of the *Giant's Causway*, (as I find by carefully examining and comparing together Pieces of them both I have now by me) and like those too, consist of regularly cut, loose and distinct Joints placed one upon the top of t'other; but in these respects they differ.

1. That some of these Inland Pillars are of much larger Size than any in the *Causway*, being two Foot and a half in Diameter.

2. That there are only found among these, such as have 3, 4, 5, and 6 Sides, and none that have 7, and 8, like some of the *Giant's Causway*.

3. That the Joints of these do not observe that kind of *Articulation*, by Cavities and Convexities, as those of the *Causway* do; but their upper and lower Surfaces touch only in Planes, and they stand united by means of

of their Weight and Pressure alone; so that a small force will sever them.

But I find by observing the manner of the Commissure, or way of *Articulation*, in six Couple of the several sorts of Joints of 3, 4, 5, 6, 7, and 8 Sides, which I had raised on purpose, and taken out of the *Causway*, as they were naturally fellow'd in *Pairs*, that some of the Joints actually want this Cavity and Rising, as those of 4 and 6 Sides I have now in my House, and are only united to one another by Superficies touching close in Planes that run a little slanting and not parallel to the Horizon. Yet this may be only a chance Formation, since the universal Jointing of the whole *Causway*, is certainly otherwise. But I must take notice, that the Hollows and Convexities are not constantly form'd and moulded in the Stone with all that accuracy and circular exactness, the Artist has pleased to express them in the Figures.

These Cavities in such Joints as are uppermost, and lie exposed to the open Air on the Surface of the *Causway*, afford no small use and advantage to the Poorer sort of People in the neighbouring Country, with whom it is a common Practice in the Summer-Time, when they want Salt, to fill these natural Basons with *Sea-Water*, which by reason of their Shallowness are of so commodious a Shape, that in the space of four Tides they find all the Water that was left in them exhaled, and the Salt remaining dry in the bottom of the Hollows.

But there is another Irregularity I must take notice of, which is, that one of the Joints of the *Causway*, a *Pentagon*, sent me hither to Town, is *Cavous* both at top and bottom: But the general Formation is this, that if a Joint be *Concave* at one end, the other end is *Convex*.

The vast towering Height of those strait-jointed Pillars, especially of those that are most slender and the perfect among them, is truly very surprising. There are in the *Causway*, some of 33, others of 36 Foot high above the Strand; and, as I said before, some among the *Organs* equal 40 Foot in height. How far these may be continued under Ground, is not yet discovered: But a Gentleman of my acquaintance traced one of the tallest *Pillars* of the *Causway* by digging into the Strand, and it continued still of the same Make and Figure, jointed as it was above, for the depth of 8 Foot together, and he found no reason to doubt but he might have traced it much farther.

This is observable, that commonly the Joints, as well of the Inland Pillars, as those of the *Causway*, as they have their Situation nigher the Earth, are longer and taller than those towards the top of the Column; but no difference is observed in the Cavities or Risings of the Joints, as they are placed higher or lower in the same Pillar: they continue much the same, as to their Depth or Protuberance from top to bottom; yet the utmost top of such of the Pillars that seem compleat and entire, always terminates with the Joint that is flat on the upper Side, and no way either *Concave* or *Convex* like all the rest below it.

As to the Internal Substance of this Stone, 'tis of an extraordinary hard, close, and compact Texture: Its Greet or Grain, so very even and fine that it hardly appears, unless viewed near the Eye, and when the Stone is newly broke: Then it shews it self on its Surface like a very minute small glistning Sand thickly interspersed with the rest of the Solid; which by reason its Parts are so firmly combined together, has something more of gravity, in proportion to its Bulk, than most other sorts of Stone, unless such as partake of the *Marchasite* or *Pyrites*, and are more ponderous than usual from a *Metalline* Principle, being an Ingredient in their Composition; of which this does not at all participate, or at least not in any considerable quantity, that I can discover.

It seems as if it were one plain homogeneous Body, without any mixture of *Cochlite*, *Belemnite*, *Veins* of *Spar*, or such like extraneous Matter, so commonly met with in most other stony Concretes: Nor can there be observed *Rays*, *Furrows*, *Striae*, or any manner of Lines running along its Superficies; so that it is capable of a good Polish, and I find has in perfection that quality of the *Lapis Lydins*, *Basamus* or *Touchstone*, so much celebrated of old, for shewing the various Impressions different Metals make upon it when rubb'd or drawn along its Surface; but being a Stone naturally divided into small Pieces or Joints, and of so hard a Body, that it turns or breaks the Edges of the best Tools, when they offer to cut it, it seems unfit for the embellishing of Houses, and all the other greater uses of *Architecture* and *Statuary*.

Its rough and natural Outside that's exposed to the open Air, and beating of the Weather, is of a whitish Colour, much the same with that we see on common Rocks, and Lime-Stone; but the Inside, when you sever one Piece from another, is of a blackish Iron-Gray, like that of the best black Marble before 'tis polish'd, but somewhat of a darker Shade. And indeed I can discover but little, if any, difference between the Substance of this Stone and that of Marble. 'Tis true, the most common sort of Marble is not near so hard and close a Body: yet that does not import much, since 'tis known that several kinds of Marble vary extremely from one another in hardness.

Georgius Agricola, in his Book *de Natura Fossilium*, has a Passage (and which I find confirmed too, by a later Author living in that Country, *Lachmand de Fossilibus*, &c.) wherein he mentions a sort of Marble found in the District of *Hildesheim* in *Germany*, that seems to bear in several respects a great analogy or agreement with this Stone of the *Giant's Causeway*. *In Hildesheim quoque e regione Arcis Marieburgi Collis est plenus Lapideis Trabibus, quarum Capita interdum eminent, sunt vero perlonga acervatim posita, inque medio earum Terra est Colore Nigro; Ferro aut altero Lapide percussa, non aliter ac Marmor Hildesheimum Cornu Usti virus olent, omninoque ex eadem Materia sunt.* He does not indeed tell us the precise Figure of these Marble Beams, yet it seems probable at least that some were square, which makes him call them, *Trabes Lapideae*. But however that might be, this I'm assur'd of from frequent Experiments, that the Marble of the *Giant's Causeway* like



Fig 152

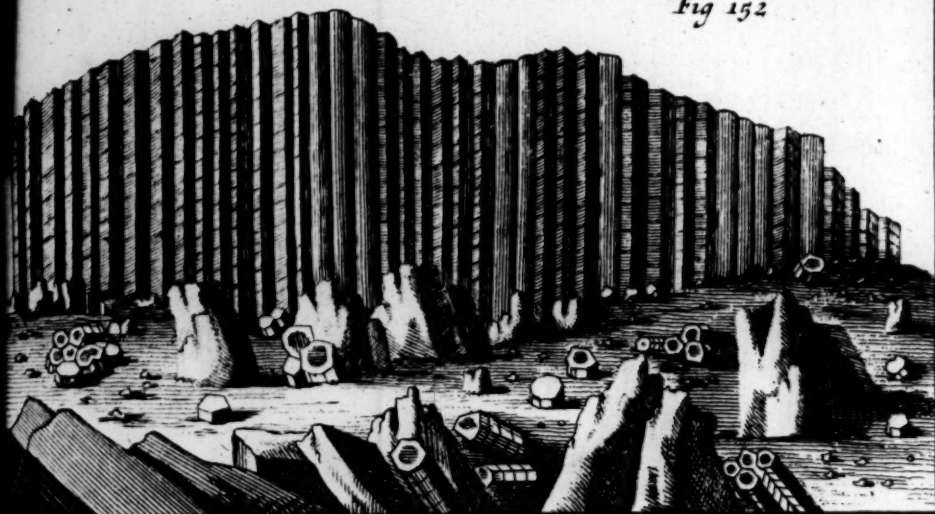
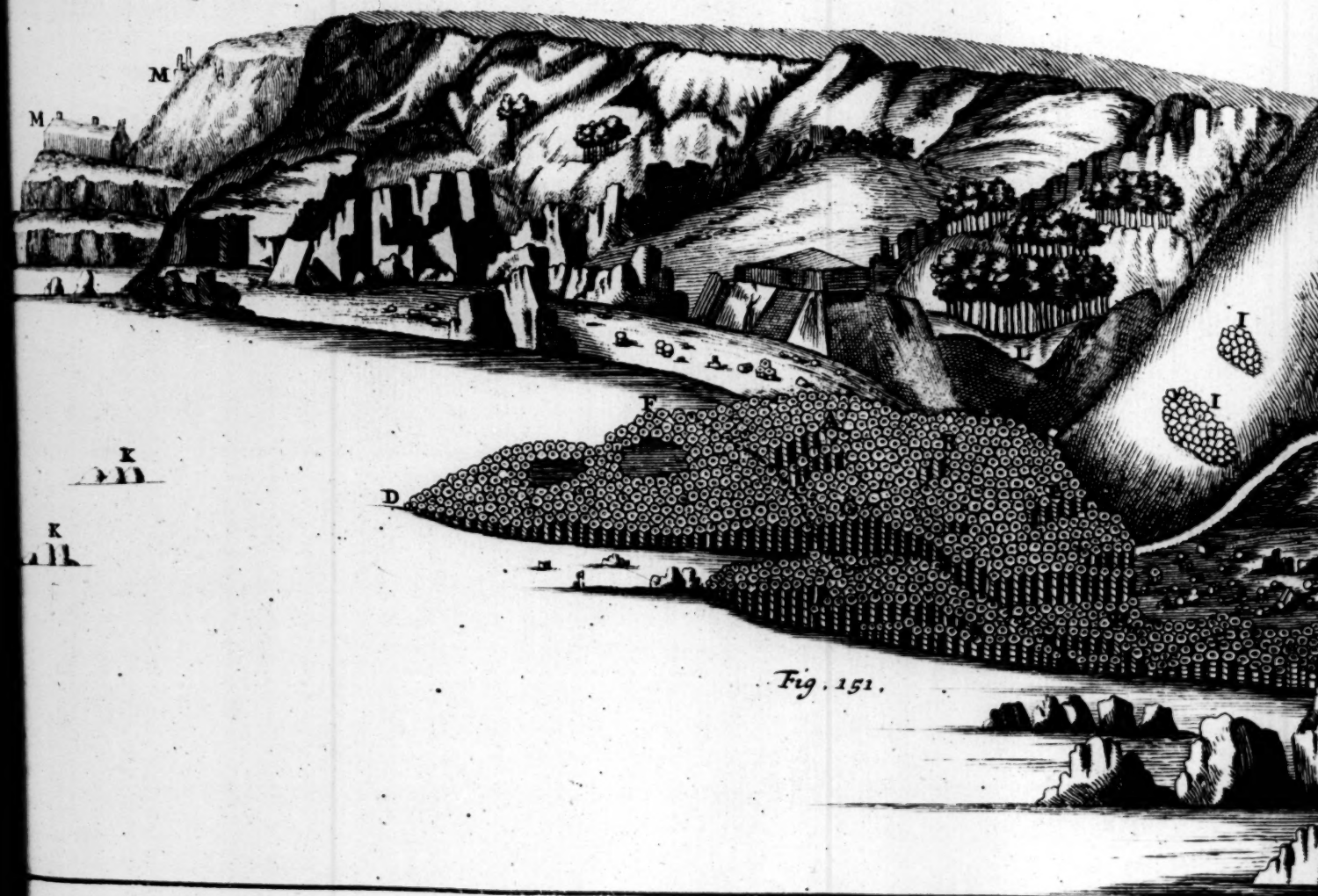
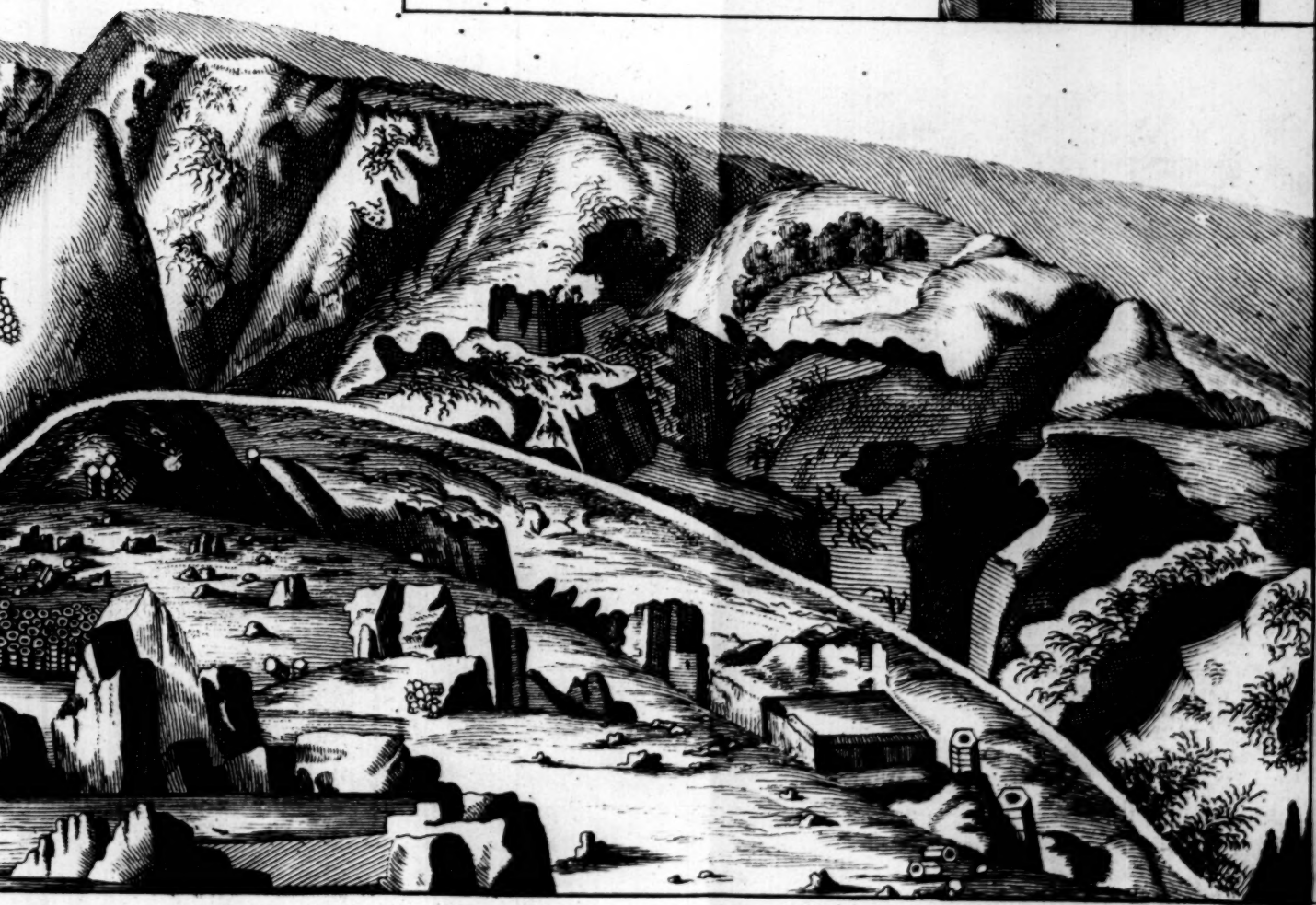
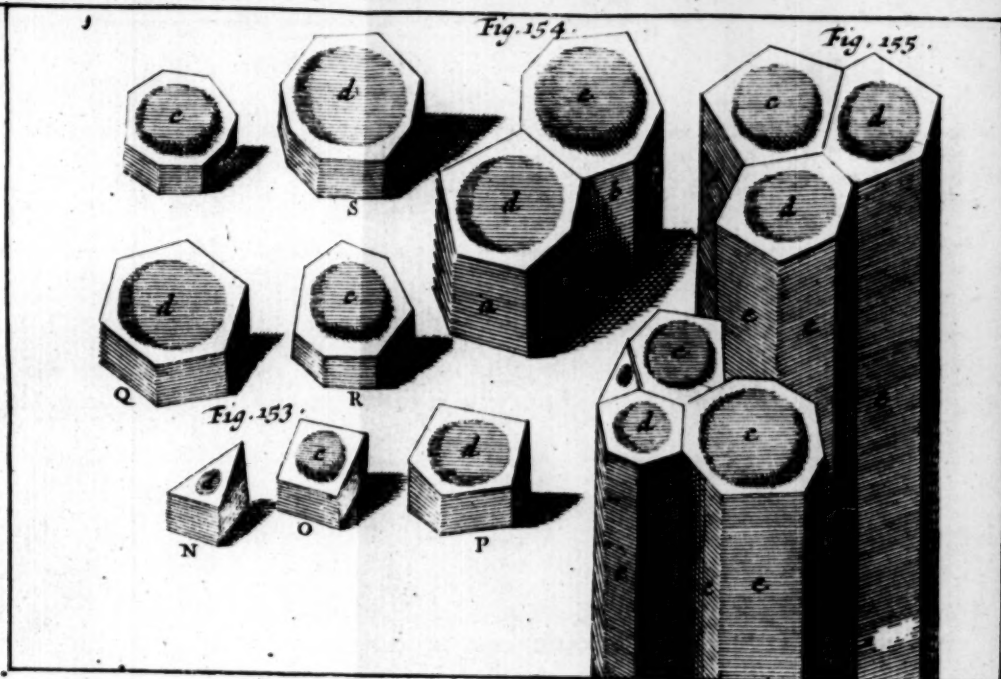
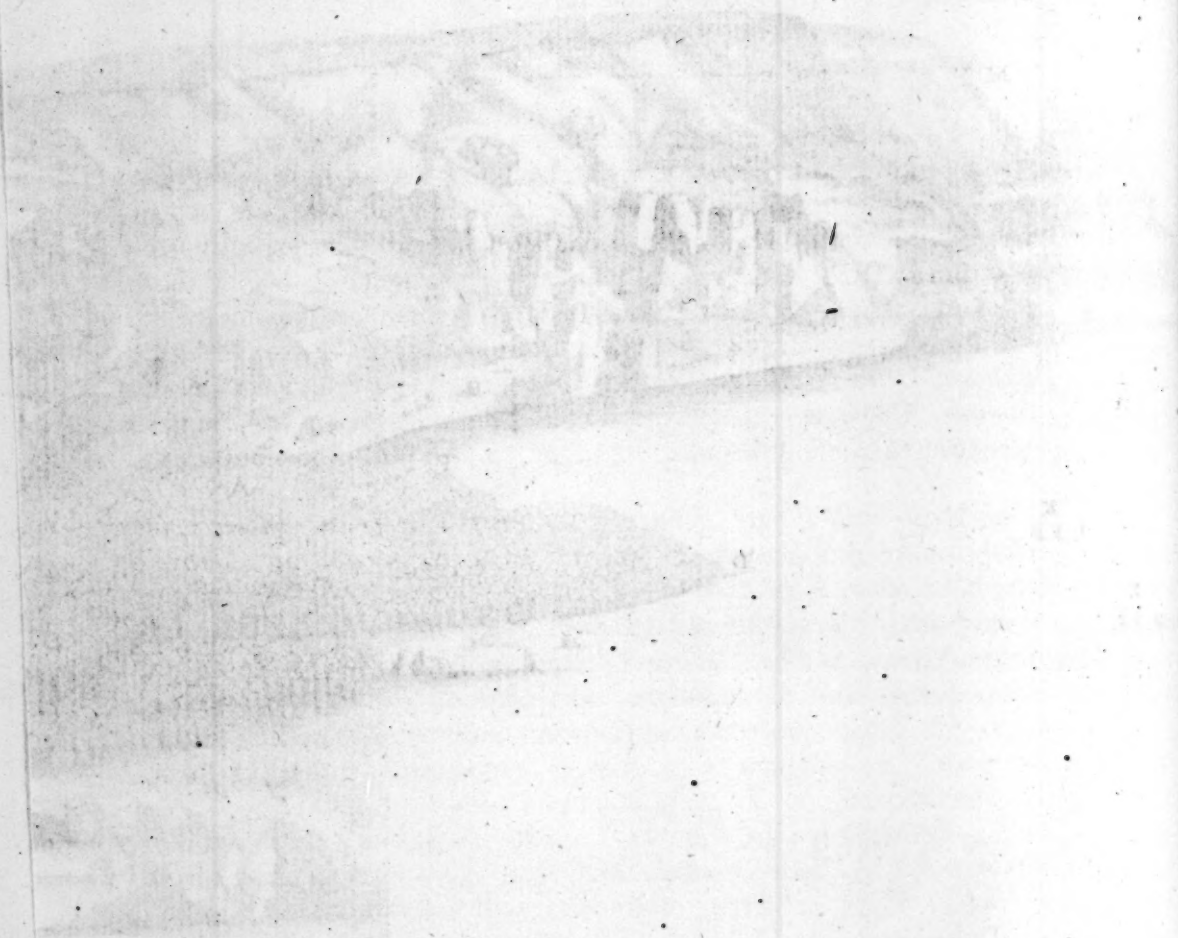


Fig. 156.







like these *stony Beams*, when forcibly struck with another Stone or a Bar of Iron, sends forth a strong offensive Scent like burnt Horn.

LXXVII. The best way to explicate the *Vegetation of Rock Plants*, is, first to represent the several Ways of the Growth of *Spar*, which (to pass by the Account from *Helvetia*, that Snow by long lying and continual Frosts is hardened into *Spar*) I observe to be three; either, 1. it takes a Being from Steams alone; or, 2. from Steams coagulating either Dew as it falls on the Ground, or Waters issuing from the Joints of the Rocks under Ground; or, 3. it grows from Earths and Clays. We have an Instance of the first in many *Grotto's*, where some *Spars*, produced from Steams alone, hang from the Roofs like *Icicles*; *Lead-Ore* often growing in the same manner: And as this *Spar* grows downwards, so, in many places from the Sides of it, there issue little Plants of *Spar* which shoot upwards, contrary to the Growth of the other. Thus *Spars* grow from Steams about the *Baths at Buda* in Hungary, according to the Relation of Dr. Brown. An Example of the 2d is given above; where 'tis said, that at a certain Place in *Italy*, Chrystals (which are a sort of *Spars*) are produced in clear Evenings, by a Coagulation of Dew falling on *nitrous Steams*. We have some of the like rise on *Mendip-Hills*; our Miners finding sometimes in Roads, where the Earth is bare, *triangular Chrystals*, about 2 Inches in length, and an Inch over; not with sharp Angles, like the *triangular Glafs*, but with round and blunt Angles, and carried up round at the Ends like a *Cocoa-Nut*; none of these being ever found in digging. I have also seen of the same sort, which were taken up in *Gloucestershire*. So again it's commonly seen in *Grotto's*, that *Steams*, coagulating *Waters*, issuing from the Joints of the Clefts, produce *Spars* of all Colours. As to the 3d Way of Generation, to wit, from Earths and Clays, because I do not remember to have met, in any Author, with a satisfactory Account thereof, I shall briefly relate to you what I have observed herein.

There are in *Mendip-Hills*, and generally where Mines are, *subterraneous Vaults or Grotto's*, whereof some which are pretty deep, and admit not Air too freely, and have other Conditions required, are said, by our Miners, to be Quick, having often Ore in them, and still lively-colour'd Earths, with some Moisture and lively *Spars*: Others admitting Air 2 or 3 ways, and having in them black and moist Rocks, and dry and rotten shelly Stones, dark Earths, barren Sands and the like, being said to be dead. I have often searched both; and in some of the former, particularly in one of them, which is 35 Fathoms deep, by a perpendicular Line (though the oblique Descent of it, makes it above 50 Fathoms to those that go into it) I discovered this Process of Nature in the Formation of *Spar*. There are in the Bottom of this *Grotto* some Beds of Clay, and others of a liver-colour'd Earth, which I take to be as good a Bole as any now in use: it is insipid to the Taste, but smells well, especially when dried; for, as it lies, it is moist and like Paste, made so partly by the distilling Waters, and partly by a Steam.

The Growth of Spar, and Formation of Rock-Plants; by Mr. J. Beaumont. n. 129. p. 744. Vid. Sup. s. LIX.

Vid. Sup. Cap. II. s. XXXIX. Vid. Sup. s. LX.

Vid. Sup. s. III.

Steam incumbent on the place raised from those *Waters* by the *Mineral Ferments*. This Earth and Clay there shoots up every where in *Spires* in all Proportions in Height, from the first Buddings out of it, till it comes almost as high as a Man's Finger; the biggest of them being in Thickness about an Inch Diameter. These *Spires* are all ruled up with irregular Ridges and Furrows, and some sooner, some later, begin on the Top to be congeal'd into *Spar*; and so gathering a Crust downward by degrees, are all at last turn'd into an absolute *white Spar*, with some *Diaphaneity*. I discovered the same Earth in some places there growing *Spherical*, which, whilst it is Earth, it is still sticking in its Bed; but afterwards, as it comes to be crusted over, and at last to be turned into *Spar* like the other, it grows clear off from its Root, as Fruit falls from the Tree when ripe. I have by me of these *Spherical Stones*, from the bigness of an ordinary Bullet, to that of a great Pin's-Head, some turning to *Spar* sooner than others: I found some quite grown off, some half grown, some *white Spar* outwardly, and raw Earth in the middle, so that the Process was as plain to me as I could wish. I saw the same Earth in some places there growing in an exact *Oval* Form, and turning into *Spar* not *Oval*, but raised on both sides with an Edge round it like *Apricock-Stones*: And as these *Spherical* and *Oval-Stones* are most exact in their Figure; so, notwithstanding the Rector fails in this Vault, to give a true *Sexangular Figure* to those which I said shoot up *Pyramidally*; yet there is a certain place on these *Hills*, where the *Spars* grow all *sexangular*, both Points of them terminating into a *Pyramidal Figure*, *sexangular* likewise, as the Veins of Chrystal found in *Italy* produced by a Coagulation of Dew; these with us probably having the same rise, lying also on the Surface of the Earth. Here I may acquaint you, that I find Talk on these *Hills* growing *sexangular*; the Rust which oftentimes lies over Veins of *Lead-Ore* in many places, shoots up *Pyramidally*, and is bounded round with 6 Angles, and sometimes with 5: *Lead-Ore* itself often shoots up *Pyramidally*, with rough irregular Lines round it, and in some places I find it bounded round very regularly with 4 Angles; in other places it grows branched like a Plant, as I have seen in a Mine where the *Stone-Plants* grow.

As to that Opinion which generally solves those various *Phænomena* of the several figur'd Stones, which we find in Mines and elsewhere, by saying, That they are part of *Plants* and *Animals*, or whole ones petrefied; it seems not to be grounded on Practical Knowledge. Thus when we find several sorts of *Shell-Fish* in Mines, as there are some in the Clay where those *Stone-Plants* grow, we must not fly to Petrefaction, as though they had been brought there by the Sea or otherwise, and so petrefied; but we must take that to be (as it is truly) the natural Place of their Birth; some of them being raw Clay, others with the same Texture with the Rock where they grow, and others of as absolute a shelly Substance as any in the Sea: these being only different Gradations of Nature, which can as well produce Shells in Mines as in the Sea, there being no want of saline or earthy

Particles. Nor is there any great difference betwixt some sorts of *Spars*, and *Sea-Shells*; neither do I know, why *Shells* might not as well be produced in *Mines*, as any sort of *Spars* are in the *Sea*: for instance, the *Fungi Marini*, which are of a *Sparry* substance, some of them having their Surface all wrought with Flowers, as it were, which are only the *Terminations* of *Sparry Cells*, as in *Coral*; and *Coral* it self is a sort of *Spar*, which so well resembles our *Stone-Plants* in its growth, especially if some of it be jointed, as Mr. Ray informs us, that I know not a more apt Name for these than to call them *Mineral Coral*; unless some haply will rather say, they are *Fluores Arborecentes internodiis distincti*; and as I find the Bodies and Branches of some *Coral* are all ruled up with Lines, so are many of these in some *Mines*, and are terminated with Cells like it.

Mr. Lister judges that *Shells* found in *Stone-Quarries* were never any part of an Animal, and gives this probable Reason for it, because Quarries of different Stone yield us quite different Species of *Shells*, not only one from another, but from any thing in Nature besides, which either the Land, salt or fresh Water, does yield. I have observed the same thing some Years since, and have now by me several Species of Stone resembling *Shell-Fish*, which I gathered from plowed Fields and Quarries, that are scarce to be parallell'd, as I judge by all the Collections of *Sea-Shells* extant. Vid. Sup. Sec. XXV.

To examine this Opinion of *Petrefaction* further; I only find, that the Thing supposed to be *Petrefied* comes first crufted over with a Stony Concretion, and afterwards, as it rots away inwardly, the *Lapidescent* Juice insinuates it self by degrees into its room, and makes at last a firm Stone, resembling the thing in Shape; which may lead some to believe it really *Petrefied*. But, though a real *Petrefaction* were allowed in some Cases, it would not be rational to plead this in all the figured Stones we see, in regard of those many grounds we have for the contrary. But I take these to be the chief Reasons which make some so ready to embrace so generally this Conceit of *Petrefaction*, because they are prepossess'd with an Opinion against the *Vegetation* of all Stones, and for that they think it impossible for Nature to express the shapes of Plants and Animals where the *Vegetative Life* is wanting, this being a Faculty peculiarly belonging to the *Soul*: whereas they seem to err in both; for as what hath been said concerning our *Stone-Plants*, may suffice to prove their *Vegetation*, so it will be as easy to shew, that Nature can and does work the Shapes of Plants and Animals without the help of a *Vegetative Soul*, at least, as it is shut up in common Seeds and Organs. To be satisfied of this, let them view the *Figurations* in Snow; let them view those delicate Landskips which are frequently (at least in this Country) found depicted on Stones, carrying the resemblance of whole Groves of Trees, Mountains, and Valleys, &c. let them descend into Coal-Mines, where generally with us the Clifts near the Coal are all wrought with curious Representations of several sorts of Herbs, some exactly resembling *Fern-Branches*, and therefore by our Miners call'd the *Fern-Branch Clift*; some resembling the Leaves of *Sorrel*, and several strange Herbs, which haply the known *Vegetable Kingdom* cannot parallel; and though it could,

here can be no Colour for a *Petrefaction*, it being only a *superficial Delineation*. The like may be said of *Animals*, which are often found depicted on *Stones*; as all *Mineral Histories* will sufficiently inform them. Now since here is no Place for *Petrefaction*, or a *Vegetative Soul*, we can only say, That here is that *Seminal Root* (though hindered by the unaptness of the Place to proceed to give these things a *Principle of Life* in themselves) which in the first *Generation* of Things made all Plants, and, I may say, *Animals* rise up in their distinct Species; God commanding the Earth and Waters to produce both, as some Plants and Animals rise up still in certain Places, without any common Seed.

It is a Thing of very difficult Search, to find what this *Seminal Root* is, which is the efficient Cause of these Figures: But it seems to me not very unapt to explicate it according to the saying of *Heraclitus*; *Lux Sicca, Anima Sapientissima*, that is, where there is a strong Internal Light to expand the Ideas, and a Drought to terminate them, the Vertue of a Soul is still present, which imprints them in the Matter. Hence we find Nature is most busy in the Kind where her Intentions are highly raised by the Presence of her chief *Principles*, Salts, Sulphurs, and Mercuries, promoting her Ferments, which cause some Internal Light and Drought, the *Ignes Fatui* being only shadowy Results from them: Thus we see over and in Beds of Clays and Marles, which have strong Ferments, being well impregnated with Salts, there often lie Beds of *Marchasites* full of *Luminous Particles*, and there we frequently find great numbers of *Lapides Serpentarii*, and *Marchasites*, resembling Snakes; and so several other figured Stones, as the *Belemnites*, &c. And in the Joints of the *Lias Stones*, growing over Beds of Clay, we often meet with a great plenty of elegant Landships. In Coal-Mines, where the Sulphurs are strong, we find great Lumps of very bright *Marchasites*, and great varieties of Herbs depicted as is said before. In Mines of Metals, where the *Mercuries* are generally predominant, there are Landships and Representations both of Land and Sea Animals, whereof some carry a bulk, others are only superficially delineated. Those who endeavour to explicate those Figurations mechanically, seem to have a harder Task; for if they say with *Hippocrates*, *Spiritu Distenta omnia pro Generis Affinitate distant*; as though when the Mineral Spirits had extended the Matter, it fell into those Figures upon a spontaneous Recess, according to its proper Weight, which gives Order and Measure to Things; as he mechanically shews by a Bladder, into which, if Earth, Sand, and Filings of Lead be put, and Water be added to them, and we give them Motion by blowing in the Bladder through a Reed, first they are mixt together with the Water, but in a while continuing in a gentle Motion they separate themselves, and retire each to its like, the Lead to the Lead, &c. I say if it be explicated thus, it seems difficult to conceive how the Matter should come to have such a determinate Weight to run into such Figures, without a *Specificcal Rector* to intend and dispose it, unless a general one be admitted, in whose Vertue all known and possible Species are, which first introducing Dispositions in the Matter, he intentionally works; and, as sometimes he gives that

Weight

Weight to the Matter, not endowing it with a *Principle of Life*, so he often disposes it to receive Life, and introduces it ; which Position I conceive will hold good, notwithstanding some late industrious Essays to prove that there is no equivocal Birth.

LXXVIII. Here is lately found in *Cheshire* a *Rock of Natural Salt*, from which issues a vigorous sharp Brine, beyond any of the Springs made use of in our *Salt-Works*. There runs near it (at least in the Winter-Season) a small Rindle (or Gutter rather ;) but it is wholly free from all danger of Overflowing, which threatens all other *Salt-Pits* in this Country every great Shower through the Vicinity of Rivers. The *Rock of Salt*, by the relation of the Workmen, is between 33 and 34 Yards distant from the Surface of the Earth. That Parcel of it which the Augur brought up was as hard as *Alum*, and as pure, and when pulverized became an excellent, fine, and sharp *Salt*. The first Discoverer of it was one *John Jackson* of *Halton*, about *Lady-Day* last, (1670) as he was searching for Coals on the behalf of the Lord of the Soil, *William Marbury* of *Marbury* Esquire.

LXXIX. There are two kinds of *Transylvanian Stone Salt* : The *Sal Gemma*, and that which is commonly used at Table. The latter is found in most of the *Salt-Mines* ; and is brought in great quantities down the River *Tibiscus*, and the Rivers running into it : Some of which is afterwards sent down the *Danube*, and up the *Morava* to furnish *Servia*, and the adjacent Provinces ; and a great part of it up the *Danube* into *Hungary*. But they bring it no higher ; *Stone-Salt* being prohibited by the Emperor in *Austria*, who hath a considerable profit upon the boiled *Salt* brought from *Hallstadt* in that Province.

I have also received an Account, that half an Hour's going from the City *Eperies*, there is a *Salt-Mine* of great Note ; from the first Place of descent unto the bottom, it is about 180 Fathoms deep : Into this the Miners descend first by Ropes, and at last by Ladders, unto the lower Parts. The Mine is for the most part in an Earthy, and not a Rocky Ground.

The Veins of *Salt* are large, and there are Pieces to be found of 10000 Pound-Weight. They commonly hew out the *Salt* into long square Pieces of 2 Foot in Length, and one in Thickness ; and for use, it is broken and grinded between two Grind-Stones.

The Mine is cold and damp, but the *Salt* being a *Stone-Salt*, is not easily dissolved, or at least in any great quantity, by dampness or moisture : Yet the Water of the Mine is impregnated with *Salt* in such sort, that being drawn out in large Buckets, and afterwards boil'd up, it affords a blackish *Salt*, which they give to their Cattle in the Country.

The Colour of the ordinary *Stone-Salt* of this Mine is not very white, but somewhat grey ; yet being broken and grinded to Powder, it becomes as white as if it were refin'd. This *Salt* consists of pointed Parts or *Fossils* : Another sort of *Salt* there is, which consists of Squares and Tables ; and a third, to be found of somewhat *stirious* or long *Shoots*.

Nor is all the *Salt* of this Mine of one Colour, but of divers ; that which is found grossly mixt with the Earth, receives some colour from it : And

even that, which is most pure, and resembleth *Chrystal*, doth often receive Tinctures of several Colours. In the middle of a Chyrstal-Salt with long Shoots, I have seen a delicate Blue; and Count *Rothal* hath a large Piece, of a fair Yellow. There are also some Pieces very clear and transparent, so hard that they carve them into divers Figures, as Crosses, Crucifixes, and others.

I cannot omit to advertise you, that whereas these Salts, though kept without Care, remain'd dry for many Months in other Countries, yet they began somewhat to relent soon after I came into *England*; and if they be kept in a Stove or very hot Place, they will be apt to lose their Transparency.

*Sal Gemma
Mines in Po-
land; By ...
n. 61. p. 1099.*

LXXX. The Mines of *Sal Gemma* in *Poland*, a Mile distant from *Cracovia*, near the small Town of *Wilizka*, which (the Church excepted) is altogether digged hollow under Ground, hath 4 Descents: Of which the two chief being in the Town it self, are those through which the Salt is drawn up; the other two do serve for letting down Timber and other Necessaries. These Descents, or Holes, are square, 4 or 5 Foot long, and as broad, lin'd downwards thorough with Timber. Above, is a great Wheel, with a strong Rope, of the Thickness of a lusty Arm, drawn about by a Horse, like as in a Horse-Mill.

He that will descend, must cover himself with a Frock, and have another Man that fastens another Rope, to the aforesaid big Rope, and having so tyed it about himself as to sit in it, takes one in his Lap and holds him fast about; whereupon the big Rope being let somewhat down, another fastens likewise a piece of Rope to the other thick Rope and does like the former, seating himself in it, and taking and clasping another Man in his Lap, and being also let down a little way, gives place to others to do the like; in which manner, 30, 40, and more Persons may be let down all at once; of whom the first having touch'd the Ground, steps out and goes aside, the rest following him and doing the like. And thus they descend to the depth of 100 Fathoms. But then they take a Lamp and lead People about by strange Passages and Meanders, still more and more descending, till they come to certain Ladders by which they go down 100 Fathoms deeper, where there are double Passages and Holes one above another, in abundance; for the Mine-Men dig on still, and cut out every where and on all Sides, as long as the Salt-Vein lasteth. The great Holes, to secure both the Town above, and the Work below from falling in, are very carefully filled out, and supported by strong and well-compacted Timber.

Out of these Mines they dig and cut out 3 sorts of Salt; one is common, coarse and black; the second somewhat finer and whiter; the third very white, and clear like Chrystal. The coarse and black Salt is cut out in great Pieces, roundish and 3 *Polonian Ells* long, and one Ell thick, which costs from 50 to 70 *Polonian Florins*.

Mean time the Inhabitants of *Cracow* have a Privilege, whereby a certain Number of Pieces is to be delivered to them, at 8 such Florins the Piece.

The

The greatest Pieces lie before their Doors, where the Cattle passing to and fro, lick off those Salt Stones, which afterwards, by Mills and other Engines, are ground and beaten small for use. The Colour of these Salt Stones is darkish Grey, with some Mixture of Yellow.

When this Salt-Work was first found, (which is now above 400 Years ago) the *Mine-Men* which first began to work in it were *Germans*; whence the *Poles* have retained the *German* Names of the *Tools*, but given them *Polish* Terminations. These *Salt-Works* belong to the King of *Poland*, who appoints and maintains the Officers of them; and 'tis one of his best Royal Revenues, amounting to a considerable Sum of Money. There is no less than 1000 Men, that are constantly employ'd in these Mines; and there was then a Provision of *Salt* valued at two Millions.

There are in these Works three Horses that stay always below, having their Stable and other Necessaries there: They carry the Salt from the places where 'tis cut and digg'd out, to those whence it is, by the abovemention'd Wheel and Ropes, drawn up by a Horse above Ground going round about. The Horses, after they have been a while under Ground, grow blind from the Sharpness of the Salt; and one of them that had been longest in those Mines, had the Hoof of his Feet grown as long again as they are usually; so that each Hoof was near a Span long. This *Salt-Work* hath also beneath it certain *Salt-Springs*, whence the *Salt Water* is by Channels convey'd to several Places, where 'tis boil'd to Salt.

But there is yet another *Mineral Salt-Work* in *Poland*, viz. at *Bochna*; but not so well ordered as the former. Besides, there are several other Places in *Poland*, and in *Russia* also, which yield Salt; as at *Holuz*, *Colomeja*, *Solum*, *Pintz*, *Ofwentz*, &c. In the *Podolian* Desert, near the River *Borisphenes*, is a Salt-Lake, whose Water is by the Heat of the Sun wadded, and turned to Salt, like unto Ice, so that the People there ride into it with Horses and Waggon, and cut it into Pieces and carry it away; as the *Polish* Historian *Cromerus* at large relateth: who also affirms, that in the aforesaid *Salt-Work* at *Bochna* they find a frozen Substance, which by them is call'd *Carbuncle*, used by the People to purge their Bodies, by Grating and Drinking it in a convenient Vehicle.

LXXXI. 1: The *Natron* of *Egypt* is an *Alkali Salt* perforated like a Sponge, The *Natron* of *Egypt* and of a *Lixivial* Taste; and thus I find it describ'd by *Pliny*, *Mathiolus*, and *Nitrian* and *Agricola*.

Its Principles I take to be chiefly two; viz. a *Sal-Marine* and an *Urinous Salt*. Water examin'd; by Dr. Ch. Leigh. n. 160. p. 609a.
That it contains a *Sal-Marine*, seems manifest by these Experiments;
1st, Because a *Solution* of the *Natron* has the same Taste that a *Solution* of *Sal-Marine* hath; 2dly, In Evaporation the Particles of the *Natron* incrustated upon the Surface of the Water, as the Particles of *Sea-Salt* do in Evaporation.
3dly, Because the *Natron* is *Perforated*, which proceeds (as I suppose) from a *Sal-Marine*, for that, when it *Chrystallizeth*, shoots with little Cavities. 4thly, If the *Natron* be mixt with *Salt* of *Tartar*, it emits the same Spirit, as *Sal-Armenciack* when mixt with the same Salt. And lastly, that it contains a *Sea-Salt*.

Salt seems plain from *Cesalpinus*, says he, *Efflorescit etiam sponte non solum in Salinis ad similitudinem Lanugenis Canescentis; sed etiam in Vasis in quibus Sal continetur.*

But here it is to be noted, that though the *Nitrian Water* is of a blusky Colour, and makes a brisk *Fermentation* with an *Acid*; yet a Solution of *Natron* looks clear, and will not ferment with an *Acid*. The Reason why a Solution of the *Natron* looks clear, though the *Nitrian Water*, which is but a Solution of the same Salt, is of a blusky Colour, may perhaps be this: I suppose that the *Water* of *Natron* receives its Redness from a red clammy Substance, which serves chiefly to cement the two Salts together. And this I rather conjecture, because, after a Solution of the *Natron* had past through a *Filire*, there stuck to it a red clammy Matter, and the Solution was clear. And the Reason why a Solution of the *Natron* will not ferment with an *Acid*, I conceive to be this; because that in a perfect Dissolution, its Parts being separated one from another, by the Parts of the *Water*, their Strugglings are too weak to make an *Effervescency* with an *Acid*; and in this I was further confirm'd by these two Experiments. I found that if into a Solution of the *Natron*, I pour'd an *Acid*, while the *Water* look'd whitish or disturb'd, the Salt not being perfectly dissolv'd, it made a brisk *Fermentation*: But when the *Water* came to be clear, the Salt then being perfectly dissolved, if I then poured an *Acid* upon it, it would not ferment. I likewise found that this Solution, being evaporated to a third part, would ferment again.

Its second Principle I take to be a *urinous Salt*: 1st. Because, if mixed with Salt of *Tartar*, it smells like *Sal-Armoniack*, when mixed with the same Salt. 2^{dly}. When it was distill'd with Salt of *Tartar* in a *Retort*, it afforded a *urinous Spirit*, as piercing as the *Spirit* of *Sal-Armoniack*.

The *Sal-Marine* (being a *Fossile Salt*) I take for granted it receives from the Earth, but it seems to have its *Volatile Alkali* from the Air: First, because it's said by *Pliny*, *Spumam Nitri* (which is the *Natron* here spoke of) *Antiqui negabant fieri nisi cum Ros cecidisset.* By *M. de la Chambre*, it is affirmed, That three or four Days before the *Nile* begins to overflow, there falls a certain Dew, which hath a fermenting Virtue, and leuens a Past expos'd to the Air; and, at the same time, saith *Pliny*, and *M. de la Chambre*, the *Nitre-Pits* grow full of *Nitre*. And *Sands*, *Vanstebius*, and several say, That though 500 in a day die in *Grand Cairo* of the Plague, before the beginning of the Inundation of the *Nile*, yet the very Day after there does not one die; which, doubtless, could not proceed from any other Reason, than because, at that time, the Air was impregnated with this *Volatile Alkali*: for, at that time, the *Nitre-Pits* grow full, and this Dew falls. This, I think, may sufficiently hint to us the great Use of its *Volatile Spirit*, especially in pestilential Distempers. Lastly, About that time that the *Nile* begins to overflow, those Specimens, which we had here at *Oxford*, grew heavier by being exposed to the Air.

Here it is to be noted, that this *Alkali* is not made so by Fire: I cannot therefore conclude with *Helmont*, that all *Alkalies* are made such by that Element.

The learned Dr. *Huntington*, (who was at *Nitria*) gives this Account of its Separation from the Water in *Latron*.

There is a Town in *Ægypt* call'd *Nitria*, which gives Name to the *Nitrian Desert*, where there is a Lake call'd *Latron*, taking up an Area of 6 or 7 Acres, situated about 30 Miles W. by S. from *Terana*, a Town lower upon the *Nile* than *Grand Cairo*, and about the same distance N. W. from the *Pyramids*; from the Bottom of this Lake, this sort of *Nitre* called *Natron* ariseth to the Top, (as they do apprehend) and there, by the Heat of the Sun, condenses into this kind of Substance. That all the *Nitre* comes from the Bottom to the Top, I dare not affirm, and shall therefore premise some *Phænomena* which it afforded in Evaporation, before I give you my Conjecture about it.

I took an *Evaporating Glass*, which held about 4 Ounces, and pour'd into it 2 Ounces of the *Nitrian Water*; this I set upon a Sand Furnace, giving it Fire by degrees: as soon as the Water was warm, the Particles of the *Nitre* began to swim upon its Surface in straggling and uneven Numbers; these, after a while, united; and at last there arose Salt sufficient to cover the whole Superficies of the Water. I took then a thin Glass and skim'd off this Ice, but could scarce take it all off before it was seconded by another; and thus the Salt did rise successively in Films, as long as there was any Water in the Glass: these Films had the Colour and Taste of the *Nitre* which came from *Nitria*, and did like it ferment with an *Acid*. And these are they which, by *Pliny*, are call'd *Flos Salis*; and, if I mistake not, the same with that which *Herodotus* says they make their *Mummy* with. If therefore by the languishing Heat of a digesting Furnace, the *nitrous* Particles could separate themselves from the Water, and over that spread themselves in an Ice; it may be as probable, that by the greater Heat of the Sun, the *Nitre* of *Latron* is separated from the Water after the same manner. And, as in the Evaporation of other mineral Waters, when the Water is not strong enough to hold up the Salt, it is generally cover'd with a thin Film; so, I suppose, in Evaporation of the *Natron*, some Parts of the Water being flown away, the Particles of the *Sal-Marine* branch one into another, and so incrustate upon the Surface of the Water.

In this *Hypothesis* I was the farther confirm'd by this Experiment: I took some of the *Natron* and dissolv'd it in Water, and set it to evaporate; and I found that the Salt did not incrustate upon the Water, till 3 parts of the Water was evaporated. It did not therefore seem probable, that the *Nitre* came all from the Bottom to the Top, and so was condensed by the Heat of the Sun; but that they incrustated, when the *Saline Particles* branched one into another, some of the Aqueous Parts being exhaled.

The Reason why its *Volatile Alkali*, in Evaporation, does not fly quite away, is, because it is held there by the *Sal-Marine*.

By the Testimony of *Hippocrates*, *Galen*, *Mathiolus*, *Diascorides*, *Pliny*, and *Agricola*, it appears to have been of great Use in Physick. But here it is to be noted, that when *Nitre* is prescribed by them, that *Nitre*, which is an Ingredient of *Gun-Powder*, is not to be understood.

Amongst

Amongst the *Moderns* we have this Account of it: *M. de Clos* is of the Opinion, that most of the *Mineral Waters* in *France* are impregnated with this sort of *Nitre*, and that all their Cures are done by it.

Molénbrochius affirms a *Tincture* of *Aphronitrum* to be of wonderful Efficacy in Stone. This I rather credit, because it's said by *Junken* in his *Medicus*, the *Nitre* of *Nitria* is of so piercing a Spirit, that it doth not permit either Stone or Rock to be thereabout.

In treating of its Use in *Agriculture*, I think it convenient to premise one *Phænomenon* which is afforded in *Evaporation*: when the Salts had spread themselves over the Water in an Ice, those thin Plates, after a while, would break and ascend in perpendicular Lines to the very Top of the Glafs: I do therefore conjecture, that *Nitre* may be said to fertilize the Ground after this manner; its *Volatile Particles* being heated by some *subterraneous Fire*, or else by the Warmth of the Sun, they do quickly ascend in the small Tubes of the Plant; and so, by their *Elastick Nature*, carry along with them, or force before them, those Particles which, as they differently convene together, constitute the different parts of the Plant.

Mund. Sub-
ter. Cap. de
Nitro.

But this Conjecture will be made something the more probable, by an Experiment in *Kircher*; where he says, If you take a wooden Tube, and put into it *Tartar*, *Quick-lime*, *Salt*, and the *Urine* of a *Wine-Drinker*, reduced into one Mass, which is to be hardened in the Sun; and after that set it in a cold Cellar, by the help of *Salt-Petre* from the before-mentioned Mass, you will, not without Admiration, see Flowers branch out of it. Yea, such is the Force of *Nitre*, that, if in a Glafs kept close shut, you put the Juices of some *nitrous Herbs* on the before-mentioned Mass, the *Nitre* contain'd within it, being pregnant with Spirit, will force itself thro' the very Pores of the Glafs.

M. de la Chambre says, *Plants* do grow in *Ægypt* in such abundance, that they would choak one another, if they were not hindred by throwing Sand upon the Fields; insomuch that the *Ægyptians* must take as much pains to lessen the Fatness of their Land, as other Nations do to encrease the Fatness of it.

Cap. de Vitri
Invent.

In *Mechanicks*, we have this Account of it: It's said by *Pliny*, that a Company of Merchants being thrown upon a Shore where there were not any Stones to be found, were forced to take great Pieces of *Ægyptian Nitre* out of their Ships and make Walls, upon which they hung their boiling Kettle: the *Nitre* being heated by the Fire, mixed with the Sand, and ran into several Streams of Glafs, which afterwards hinted the way of making Glafs. It is likewise of use in Dying, for *Pliny* and *Virruvius* affirm, That, by the help of this, the true *Azure* is made; and that without this, there cannot be a true Shadow.

This *Nitre* is distinguish'd from *Salt-Petre*, 1. By its fermenting: It will ferment with any *Acid*, but *Salt-Petre* will not. I found that it would ferment with *Vinegar*, as the old Commentators observe in their Comments upon *Jeremiah* and the *Proverbs*, but *Salt-Petre* will not: which gave Occasion to some, in those Texts, to alter the Word *Nitre*.

2. It may be distinguish'd from *Salt-Petre* in its Taste ; for *Natron* hath a *Lixivial* Taste, but the other not.

3. By the *Volatile Spirit* which it affords : For from the one comes over a *Volatile Alkali*, but from the other a *Corrosive Acid*.

4. The *Natron* affords a red clammy Substance, insipid, but the other not. This clammy Substance (if I mistake not) is that which by *Pliny* is call'd *Ærugo Salis* : This it hath from the Earth, and therefore it is again said by *Pliny*, *Sunt ibi Nitrariæ in quibus & Rullum exit a Colore Terræ*.

5. Like *Salt Petre* it will not *Chrystallize*.

6. In the Fire, it makes no *Detonation*.

But in this it resembles *Salt-Petre* ; as that, by the Flowers of Sulphur, is made into a *Sal Prunellæ*, so this, if you drop *Spirit* of Sulphur upon it, shoots into *Pyramidal Salt*, that is not by the Taste distinguishable from *Sal Prunellæ*, though its Taste before was *Lixivial*.

From *Sal-Armoniack* it may be distinguished : First, by its Colour ; for the *Natron* is reddish, the other not : Secondly, by the Texture of its Parts ; in *Sal-Armoniack*, the Parts seem close and firmly knit together, but the *Natron* is spongy and perforated : Thirdly, if mixed with *Sal-Armoniack*, the *Sal-Armoniack* emits the same Spirit, as it doth, when mixed with *Quick Lime*.

But I think it comes much nearer to the Nature of *Sal-Armoniack* than *Salt-Petre* ; 1st, Because it is compos'd of a *Sea-Salt* and an *Urinous Alkali* : 2^{dly}, Like *Sal-Armoniack*, when dissolv'd in Water, it makes it extremely cold ; and, as *Franciscus Hernandez* says, it produces the same Effect, when dissolved in Wine. *Hist. of Mexico,*

2. The *Nitre* of *Egypt*, by the Experiments made about it at *Oxford*, The Original of the Nitre of Egypt, by Dr. Lister. n. 167. p. 837. plainly appears to be little different from *Sal-Armoniack* : and considering, that it rains little or nothing, comparatively to the great Heats, in *Egypt* ; and that the Lakes there are only once a Year furnish'd with fresh Water from the Overflowings of the *Nile* ; also that vast Tracts of Land there, and all over *Asia*, are naturally cover'd with *Fossile Salt* ; again, that those Lakes are furnish'd with vast Animals, as *Crocodiles*, *Hippopotami*, and without doubt great variety of other lesser Vermine : these things, I say, well consider'd, it is easy to think, that in a Year's Time, most of the salt Water of those Lakes has pass'd through the Bodies of those Animals, and consequently is become *Urinous* or *Salino-Urinous*, as is the Nature and Composition of *Fæctitious Sal-Armoniack*.

LXXXII. I am convinced that Sulphur is sublimed from the Pyrites, according to the Opinion of *Dr. Lister* ; especially that gather'd upon Mount *Ætna*, *Vesuvius*, the *Solfatara*, and in the Stoves of *St. Gennaro*, not far from thence : for most of the Stones and Cinders, thrown out of those mighty Furnaces, do manifestly contain Iron, if we may believe the *Magnet*. As The Pyrites and Lapis Calcarinus consider'd; by Dr. Tanc. Robinson. n. 169. p. 924. to the Salt (taken by many Writers to be a sort of *Sal-Armoniack*) found together with the Sulphur in the foremention'd Places, it appeared to me to be a kind of *Nitrum Calcarium* ; for as I remember, it had not any *Urinous* Qualities,

Qualities, that I could perceive by slight Tryals of Mixture; and I was the more confirmed in my Opinion, after I had seen and considered, the great Quantity of Lime-Stone round about *Naples*; many Beds of it lying up and down the *Terra di Lavoro*, or *Campania Felice*.

The Spontaneous Firing of the Pyrites; By Dr. Fred. Slare. n. 213, p. 218.

LXXXIII. The Master of a *Copperas* Work at *Whitestable* in *Kent*, having engross'd all the *Pyrites* or *Copperas Stones* to himself, laid up two or three hundred Tun in a Heap, and built a Shed over it to keep off the Rain: But in the space of 6 or 7 Months it first smoaked, and then took fire, and burnt for a Week. Some of it looked like melted Metal, and other Parts like red-hot Stones; and it discharg'd so fetid, sulphurous, or stinking Exhalations, that the People in the Neighbourhood were miserably afflicted, and forced to use all their Endeavours to extinguish it.

A Mineral at Liege, yielding Brimstone and Vitriol; By Sir Rob. Moray. n. 30. p. 45.

LXXXIV. The *Mineral* out of which Brimstone and Vitriol are extracted is one and the same, not much unlike Lead-Ore, having also oftentimes Lead mingled with it, which is separated from it by picking it out of the rest. The Mines resemble our *English* Coal Mines, dug according to the depth of the *Mineral*, 15, 20, or more Fathoms, as the Vein leads the Workmen, or the Subterranean Waters will give them leave.

To make Brimstone, they break the Stone or Ore into small Pieces, which they put into *Crucibles*, made of Earth 5 Foot long, Square and Pyramid-wise; the Entry is near a Foot Square. These *Crucibles* are laid sloping, eight undermost, and seven above them, as it were betwixt them, that the Fire may come at them all, each having its particular Furnace or Oven. The Brimstone being dissolved, by the violence of the Heat, drops out at the small end of the *Crucible*, and falls into a Leaden Trough or Receptacle, common to all the said *Crucibles*, through which there runs a continual Rivulet of cold Water, conveyed thither by Pipes, for the cooling of the dissolved *Sulphur*, which is ordinarily 4 Hours in melting. This done, the Ashes are drawn out with a crooked Iron, and being put into an Iron-Wheel-barrow, are carryed out of the Hutt, and being laid in a Heap, are covered with their other elixed or drained Ashes, the better to keep them warm; which is reiterated as long as they make Brimstone.

To make *Copperas* or *Vitriol*, they take a quantity of the said Ashes, and throwing them into a square planked Pit in the Earth, some four Foot deep and eight Foot square, they cover the same with ordinary Water, and let it lie 24 Hours, or until an Egg will swim upon the Liquor, which is a sign that it is strong enough. When they will boil this, they let it run through Pipes into the Kettles, adding to it half as much *Mother-Water*, which is that Water which remains after the Boiling of the *Hardened Copperas*. The Kettles are made of Lead, $4\frac{1}{2}$ Foot high, six Foot long, and three Foot broad, standing upon thick Iron Bars or Grates. In these the Liquor is boiled with a strong Coal Fire, twenty four Hours or more; according to the Strength or Weakness of the *Lee* or *Water*. When it is come to a just Consistence, the Fire is taken away, and the boil'd
Liquor

Liquor suffered to cool somewhat, and then 'tis tapp'd out of the said Kettles through Holes beneath in the sides of them, and conveyed through wooden Conduits into several Receptacles, three Foot deep and four Foot long (made and ranged not unlike our Tan-Pits) where it remains 14 or 15 Days, or so long till the *Copperas* separates itself from the Water, and becomes icy and hard. The remaining Water is the above-mentioned *Mother-Water*; and the elixed or drained Ashes are the *Dregs*, or *Caput Mortuum*, which the *Lee*, whereof the *Vitriol* is made, leaves behind it in the planked Pits.

LXXXV. 1. There is a *Stone* in *Sweden* of a yellow Colour, intermixed with Streaks of white, (as if composed of Gold and Silver) and heavy withal. It is found in firm Rocks, and runs in Veins, upon which they lay Wood and set it on fire. When the *Stone* is thus heated, they cast Water upon it, to make it rend, and then then dig it up with Mattocks. This done, they break it into smaller Pieces, and put it into Iron Pots, of the shape represented by *Fig. 153.* the Mouth of the one going into the other. These they place the one in the Oven upon an Iron Fork sloping, so that the *Stone* being melted, it may run into the other, which stands at the Mouth of the Oven, supported upon an Iron. The first running of the *Stone* is *Sulphur*.

Sulphur, Vitriol, Alum, and Minium, from a Stone in Sweden; By Sir Gilb. Talbot. n. 21. p. 375.

The remainder of the burned *Stone* is carried out, and laid upon a high Hill, where it lies exposed to the Sun and Air for the space of two Years; and then taketh fire of it self, casting forth a thin blue Flame, scarce discernible in the Day-Time. This being consumed, leaveth a blue Dust behind it; which the Workmen observe, and mark with Wooden Pins. This they dig up, and carry into the Work-House, and put it into great *Tubs* of *Water*, where it infuseth 24 Hours, or more. The *Water* they afterward boil in Kettles, as we do *Salt-Peter*, and put it into cooling *Tubs*, wherein they place cross Sticks, and on them the *Vitriol* fastens, as *Sugar-Candy* doth.

The *Water* that remains after the Extraction of the *Vitriol* they mix with an 8th part of *Urine* and the *Lees* of Wood Ashes, which is again boiled very strong, and being set to cool in *Tubs*, cross Sticks are likewise fastened, and thereon the *Alum* fastens.

In the *Water*, which remains after the *Alum*, is found a *Sediment*, which being separated from the *Water*, is put into an Oven, and Wood laid upon it and fired, till it become red, which makes the *Minium*, wherewith they paint their Houses, and make Plaster.

2. There is a kind of *Stone* in the North of *England*, yielding the same Substances, except *Minium*.

The same in England; By . . . ib. p. 376.

LXXXVI. *Copperas* Stones, which some call *Gold Stones*, are found on the Sea-Shore in *Essex*, *Hampshire*, and so Westward. There are great Quantities in the Cliffs; but not so good as those on the Shore, where the *Tides* ebb and flow over them.

Green Copperas Works; By Mr. Daniel Colwall. n. 142. p. 1056.

The best of them are of a bright shining Silver Colour; the next such as are of a rusty deep Yellow; the worst such as have Gravel and Dirt in them, of a sadder *Umber* Colour.

In the midst of these Stones, are sometimes found the Shells of *Cockles*, and other small *Shell-Fishes*; small Pieces of the Planks of Ships, and Pieces of Sea-Coal.

In order to the making of *Copperas*, they make Beds according as the Ground will permit; those at *Deptford*, are about 100 Feet long, 15 Feet broad at the top, and 12 Foot deep, shelving all the way to the bottom.

They ram the Bed very well, first with strong Clay, and then with the Rubbish of *Chalk*, whereby the Liquor, which drains out of the Dissolution of the Stones, is conveyed into a Wooden shallow Though, laid in the middle of the Bed, and covered with a Board; being also boarded on all sides, and laid lower at one End than the other, whereby the Liquor is conveyed into a Cistern under the Boiling-House.

When the Beds are indifferently well dried, they lay on the Stones about 2 Feet thick.

These Stones will be five or six Years before they yield any considerable quantity of Liquor; and before that, the Liquor which they yield is but weak.

They ripen by the Sun and Rain: Yet Experience proves, that the Watering the Stones, although with Water prepared by lying in the Sun, and poured through very small Holes of a Watering-Pot, doth retard the work.

In time these Stones turn into a kind of *Vitriolick Earth*, which will swell and ferment like Leavened Dough.

When the Bed is come to Perfection, then once in four Years they refresh it, by laying new Stones on the top.

When they make a new Bed, they take a good Quantity of the old fermented Earth, and mingle it with new Stones, whereby the Work is hastened. Thus the old Earth never becomes useless.

The Cistern before mentioned is made of strong Oaken Boards, well jointed and calked. That at *Deptford* will contain 700 Tuns of Liquor. Great care is to be taken, that the Liquor doth not drain through the Beds, or out of the Cistern. The best way to prevent the same, is to divide the Cistern in the Middle, by Oaken Boards, calked as before; whereby one of them may be mended in case of a Defect.

The more Rain falls, the more, but the weaker will be the Liquor; the Goodness whereof is tryed by Weights prepared for that purpose: Fourteen Penny-Weight, is Rich; or an Egg being put into the Liquor, the higher it swims above the Liquor, the stronger it is. Sometimes the Egg will swim near half above the Liquor.

Within one Minute after an Egg is put in, the ambient Liquor will boil and froth; and in three Minutes the Shell will be quite worn off.

A Drop of this Liquor falling on the Manufactures of *Hemp*, *Flax* or *Cotton Wool*, will presently burn a Hole through it: as also in *Woollen* and *Leather*.

Out of the aforesaid Cistern, the Liquor is pumped into a Boiler of Lead, about 8 Feet square, containing about 12 Tuns, which is thus ordered. First they lay long Pieces of Cast Iron, 12 Inches square, as long as the Breadth of the Boiler, about 12 Inches one from another, and 24 Inches above the Surface of the Fire. Then cross-wise they lay ordinary flat Iron Bars, as close as they can lie, the Sides being made up with Brick-work. In the middle of the bottom of this Boiler is laid a Trough of Lead, wherein they put at first 100 Pound Weight of old Iron.

The Fuel for boiling is *Newcastle-Coals*. By degrees, in the boiling, they put in more Iron, amounting in all to 1500 Pound Weight in a Boiling. As the Liquor wastes in boiling, they pump in fresh Liquor into the Boiler; whereby, and by a Defect in ordering the Fire, they were wont to be above 20 Days before it was enough; when that is, they try, by taking up a small Quantity of Liquor into a shallow earthen Pan, and observing how soon it will gather and crust about the Sides thereof. But now of late, by the ingenious Contrivance of Sir *Nicholas Crisp*, the Work is much facilitated; for, at his Work at *Deptford*, they boil off three Boilers of ordinary Liquor in one Week; which is done, first by ordering the Furnace so, as that the Heat is conveyed to all Parts of the Bottom and Sides of the Furnace.

Then whereas they were wont to pump cold Liquor into the Boiler, to supply the Waste in boiling, whereby the Boiler was checked sometimes ten Hours, Sir *Nicholas* hath now a Vessel of Lead, which he calls a Heater, placed at the end of the Boiler, and a little higher, supported by Bars of Iron as before, and filled with Liquor, which, by a Conveyance of Heat from the Furnace, is kept near boiling hot, and so continually supplies the Waste of the Boiler, without hindring the boiling. *Thirdly*, By putting due Proportions of Iron from time to time into the Boiler; as soon as they perceive the Liquor to boil slowly, they put in more Iron, which will soon quicken it. Besides, if they do not continually supply the boiling Liquor with Iron, the *Copperas* will gather to the bottom of the Boiler; and melt it; and so it will do if the Liquor be not presently drawn off from the Boiler into a Cooler, so soon as it is enough.

The Cooler is oblong, 20 Feet long, 9 Feet over at the top, 5 Feet deep, tapered towards the bottom, made of Tarras. Into this they let the Liquor run, so soon as it is boiled enough. The *Copperas* herein will be gathering or shooting 14 or 15 days, and gathers as much on the Sides as in the bottom; *scil.* above 5 Inches thick. Some put Bushes into the Cooler, about which the *Copperas* will gather, but at *Deptford* they make no use of any.

That which sticks to the Sides, and to the Bushes, is of a bright green, that in the bottom of a foul and dirty Colour.

In the end of 14 Days they convey the Liquor into another Cooler, and reserve it to be boiled again with new Liquor.

The *Copperas* they shovel on a Floor adjoining, so that the Liquor may drain from it into a Cooler.

The Steam, which comes from the Boiling, is of an acrimonious Smell

Copperas

Copperas may be boiled without Iron, but with difficulty; without it the Boiler will be in danger of melting.

Sometimes, in stirring the Earth upon the Beds, they find Pieces of *Copperas*, produced by lying in the Sun.

Oil of Vi-
triol increa-
sing in
Weight;
by Dr. Will.
Gold. n.
156. p. 496.

Vid. sup.
cap. I. §.
XVI.

LXXXVII. Some Druggists have accidentally taken notice of an Increase of Weight in Oil of *Vitriol* exposed to the Air (and perhaps have improved it to their own Gain, though to the Detriment of the Buyer.) And the industrious Chymist Mr. *White*, the University-Operator at *Oxford*, had a Viol of that Liquor unstopt and constantly running over: But since from thence no true Estimate of the just *Encrease* could be collected, I shall here give you what has occurred more particularly on this Subject.

Nov. 4 1683. Three Drams of Oil of *Vitriol*, so far *dephlegmed* as to burn or corrode a strong Packthread asunder, was exposed to the Air in a Marmalade Glass of three Inches Diameter, and placed in a nice Pair of Scales, in a Room where no Fire nor Sun came; its Increase for seven natural Days, divided by less Portions of Time, was according to the following Table.

Nov. 1683.		Gain.	Space of Time.	Weather.	Wind.	Sum of Gain.	Natural Day.
D.	H.						
9	3 p. m.	3 3 gr.	H.	Moist.		3 3 gr.	
		3 0 00					
10	11 p. m.	0 0 19	6 h.	Moist and	Southerly.		
	8 m.	0 1 12	9	Windy.	N. Westerly.		1st.
	11 m.	0 0 08	3	Rainy Morn.		1 0 08	
	5 p. m.	0 0 09	6	Clear.			
11	11 p. m.	0 0 18	6	Star-lig. Cold, bright Morn.	N. W.	0 2 18	2d.
	8 m.	0 1 07	9	Mild.			
	11 m.	0 0 04	3	Mild, Dry			
	5 p. m.	0 0 09	6	Weather.			
12	11 p. m.	0 0 10	6	Mild, Dry,	N. W.		
	8 m.	0 0 17	9	Clear Morn.	N.	0 1 19	3d.
	11 m.	0 0 05	3	Fresty.	N. more.		
	5 p. m.	0 0 07	6	Overcast.	W.		
13	11 p. m.	0 0 06	6	Cloudy, Rain.	Westerly.		
	8 m.	0 0 09	9				
	11 m.	0 0 03	3	Cloudy.	S. W.	0 1 3 $\frac{1}{2}$	4th.
	5 p. m.	0 0 05 $\frac{1}{2}$	6	Mild.			

14	11 p. m.	0 0 06	6	Cloudy, Mifty.	S. E.	0 0 18	5th.
	8 m.	0 0 08	9	Cloudy, Mifty.			
	11 m.	0 0 02 $\frac{1}{2}$	3	Mifty.	Southerly.		
	5 p. m.	0 0 01 $\frac{1}{2}$	6	Very warm.			
15	11 p. m.	0 0 02	6	Cloudy, unusu- ally Warm.	More S.	0 0 15	6th.
	8 m.	0 0 06	9	Cloudy.	S. E.		
	11 m.	0 0 03	3	Cloudy Moist.	More S.		
	5 p. m.	0 0 04	6	Clear Coldish.	Easterly.		
16	11 p. m.	0 0 04 $\frac{1}{2}$	6	Dry Starlight.	Easterly.	0 0 17	7th.
	9 m.	0 0 09	10	Cold, Cloudy but Cold.			
	11 m.	0 0 02	2	Cloudy, Windy.	S. E.		
	5 p. m.	0 0 02	6	Cl. very Mild.			

From the 16th, in the successive Spaces of 24 Hours, each gained one of the Number of Grains following; as the 8th natural Day gained $13 \frac{1}{2}$, the next 12; 9, 7, 6, 5, $5 \frac{1}{2}$, $4 \frac{1}{2}$, 3, 3, 3, 3, 4, 3 (Decemb.) $4 \frac{1}{2}$, $4 \frac{1}{2}$, 4, 3, 3, &c. still irregularly decreasing till the Liquor was satiated. The Diary was continu'd to Jan. 4. 1684. when the Increase, in 24 Hours, amounted scarce to half a Grain; and probably had the Weather been then dry, it might have been none at all, or rather the Liquor might have lost what before it had gained.

Hence 'tis obvious, that the more our Liquor was saturated, the less was its daily Increase, though not gradually less by an even Descent each Day, but sometimes two or more natural Days together it was exactly the same, a Day or two after less, and then again more the next Day following, according as the Liquor stood affected by the Heat and Cold, Dryness or Moisture of the Weather, the differing Time of the Day, and Quarter of the Wind. Thus, upon the view of the whole Diary of almost two Months, it appeared, the Increase was more in a moist, rainy, misty, and snowy, but less in a frosty, clear, and dry Season; as also it was more in a cold than in a warm Air. When the Wind was Northerly or Easterly, the Gain was less, *ceteris paribus*, than when Southerly or Westerly, and was less in the Day than in the Night. The primary Cause of this Phenomenon seems to be the Moisture of the Air, which our Liquor (a potential Fire) imbibes as greedily, as actual Fire does the *Pabulum* of Nitre; yet we must allow that all the other Circumstances of Season, just now mentioned, have each their particular Influences in diversifying the Quantity of the Increase. Thus it appears in the Table, that Heat alters the Progress of increasing; for on the 14th of Novemb. from 11 m. to 11 p. m. (at which time, especially towards Night) a very unusual and troublesome Heat in the Air was complained of by several here in Oxford; in 12 Hours the Gain was only $3 \frac{1}{2}$ gr. whereas, in the like time preceding, it was $10 \frac{1}{2}$ Grains, and in that just following 9 Grains.

Neither

Neither indeed can any thing otherwise be expected from Heat, since thereby the Moisture might rather be exhaled, or at least might be suspended, agitated, and intimately mixed with the Substance of the Air, and consequently not so easily be arrested and entangled by the Surface of the Liquor, as when the Air is less hot. However, allowing the Effect of this *anomalous Accident*, at a time of the Year when least expected, and considering that most commonly Heat keeps even pace with the Season of the Year; depending, as to its Temper, for the most part on the Nearness or Remoteness of the Sun: we may safely conclude, Moisture the chief and only Cause of the Increase of Weight in *Oil of Vitriol*, since in dry clear Weather it constantly increases less than in moist and cloudy; the Circumstance of Heat or Cold remaining the same in both.

But this will be clearly evinced, by an Inquiry made into the Nature of the Substance gained with the Increase of Weight: For by the ordinary ways of Tryal it appeared, the *Atmosphere* afforded our Liquor nothing besides some of its *Warry Particles*, wherewith it always abounds; but more especially is ready to part with in moist Weather.

The Air, without doubt, has great Variety of different Substances floating in it, whereof some Particles do adhere to this, some other sort to that Body, according as either is peculiarly dispos'd to receive one sort rather than another. Thus the Mortar in the Joints of old Walls and Vaults, from Corpuscles attracted from the Air, spouts out and frames a peculiar kind of Salt. I have known a Deal Shelf, moistened only with the Liquor of *fixed Nitre*, frosted over with *Chrystals* of a perfect *inflammable Nitre*, by regaining the proper *Acids* from the Air, all one as if so much Spirit of *Nitre* had been poured on the said Liquor. I have seen a Viol half-filled with *Oil of Tartar per Deliquium* (by being left open to the Air) beset above the Liquor with peculiarly figured *Chrystals*, and at the bottom were flat *Chrystallized Plates* of a Salt, which, without Flame, crackled on a live Coal, and left behind a *Calx* much like *Dr. Lister's Nitrum Calcarium*. And 'tis well known *Colcothar* of *Vitriol*, reimpregnated by the Air, will, by a fresh Distillation, give you its proper *Acid* as at first. Now upon such Hints as these, some (fond of the Doctrine of *Alkali* and *Acid*) might perhaps expect, since differing Bodies of an *Alcalizate* Nature do thus regain their proper *Acids*, that, *vice versa*, even this most *Acid* Liquor, *Oil of Vitriol*, also might find its *Alcalizate* Associate in the Air, from which the Violence of Fire had before driven it. But we could discover no such Matter; the Taste of our augmented Liquor was still purely *Acid*, and only weaker than before; whereas it would have been saltish, had an *Alkali* been combined with it, and its Colour, from a deep reddish, became *limpid*, all one as if the like Quantity of fair Water had been mixed. But to be more certain in this Point, I distilled of the new-gained Substance: At first it came over as insipid as clear Water; and urging the Fire farther, the Drops proved sour, and the remaining *Oil* in the *Retort* was altogether as *corrosive* as at first. Whence we may infer, its Edge was not at all blunted by any adjoined *Alkali*; so that what the Air afforded, was nothing else but mere *Water* only.

As

As to the Quantity of the whole Increase, it can't be determin'd by any general Rule, since it varies according to the different Strength of the Oil of Vitriol; for it appears by the Table, the more diluted the Liquor, the less attractive it proved. This here employed, (as highly dephlegm'd, I presume, as any usually is) gave a Triple, and more than $\frac{1}{2}$ of its first Weight, amounting in all from 3 to 9 Drams, and 30 Gr. before it came to a Stand.

Which Proportion of Increase I found confirmed in lesser Quantities also; as 3 gr. increased to more than 9 gr. and one Grain gave the Weight of something more than 3 Grains. But besides the Strength of the Liquor, there are other Circumstances, as the Season of the Year, and Position of the Place, which will certainly something alter this Point; thus our Liquor will gain more in Winter than in Summer, more in a Cellar and sun-less Room, than in a Room not so qualified.

All these Circumstances, which relate to the Quantity, will also influence very much the Time of the Increase, but what makes the most peculiar and principal Variation in this Point, is the Proportion of the Surface to the Bulk of the Liquor. For I find the greater or less the Surface is, the quicker or slower the Increase. Thus three Grains dropt and diffused to near $\frac{1}{2}$ Inch breadth on a Piece of Glass, gain'd 3 Gr. in 6 Hours; one Gr. in 6 more; one Gr. and $\frac{1}{2}$ in 12 Hours more; in the next 12 Hours it gained $\frac{1}{2}$ Gr. and in the last 12 Hours it gained very little observable: so that in less than 48 Hours, having more than triple its first Weight, it was for some time fully satiated, till rainy Weather added something more.

But to discover more nicely what Interest the Proportion of Surface has in hastening or retarding the Increase of Weight, I expos'd in the same Room, and to the same Temper of the Air (as near as I could guess) 3 Drams of the same Oil of Vitriol in an open flat Glass one Inch broad, being only $\frac{1}{4}$ of the Diameter of that Glass us'd at first with the like Quantity. The Result was this, that whereas the other Surface of 3 Inches Diameter, gain'd (as in the Table) near 19 Gr. the first 6 Hours, this less Surface gain'd a very little perceivable more than 2 Grains in the same Space of Time. Now since the Area's of Circles are to one another as the Squares of their respective Diameters; as 1] the Square of the Less, is to 9 the Square of the greater Glass's Diameter, so was the Weight of a little more than 2 Grains gain'd in the narrower Glass, to near 19 Gr. gain'd in the broader: Wherefore the Time of Increasing bears, as near as can be expected, an exact Proportion to the Surface of the Liquor expos'd, and the Liquor in the lesser Glass having but $\frac{1}{4}$ part of the Surface of the greater, could not be satiated under 9 times as many Days as the greater.

LXXXVIII. All I can find of the Origin of White Vitriol is out of Borrichi-
us de Docimaſtice Metallica, that it is produced from a certain Lead Ore boil'd White Vitriol, by Dr. Lister, n. 256. p. 331.
raw. (*Plumbi Nigri Vena Vitriolum Album producit, etiam non Cremata.*)
None that I know of, of our English Lead Ores gives us any suspicion of
any such Vitriol. It is true, I have by me some sorts of White Lead Ore,
Spar-Like, plentifully yielding Lead; but I cannot say, that either those, or
Vol. II. Z z z any

any coloured *Lead Ores*, did give me any reason to suspect, after divers Experiments upon them, that they yield white *Vitriol*.

As to the *Chrystals* of white *Vitriol*, they are very difficult to describe, and seem to me to be a Congeries of infinite small Needles; for which reason they are of a most speedy Operation, and irritate the Stomach suddenly, before they can be well dissolv'd or broken.

Alum
Works, by
Mr. Dan.
Colwal. n.
142. p. 1052.

LXXXIX. *Alum* is made of a Stone, of Sea-Weed and Urine.

The Stone is found in most of the Hills between *Scarborough* and the River of *Tees* in the County of *York*; as also near *Preston* in *Lancashire*. It is of a blueish Colour, and will cleave like *Cornish Slate*.

The Mine, which lies deep in the Earth, and is indifferently well moistned with Springs, is the best. The dry Mine is not good; and too much Moisture cankers and corrupts the Stone, making it nitrous.

In this Mine are found several Veins of Stone call'd *Doggers*, of the same Colour, but not so good. Here are also found those that are commonly called *Snake-Stones*; the People have a Tradition, that the Country thereabouts being very much annoyed with Snakes, by the Prayers of *St. Hilda*, there inhabiting, they were all turned into Stones, and that no *Snake* hath ever since been seen in those Parts.

For the more convenient working of the Mines, which sometimes lie 20 Yards under a Surface or Cap of Earth, (which must be taken off and barrow'd away) they begin their Work on the declining of a Hill, where they may be also well furnished with Water. They dig down the Mine by Stages to save Carriage, and so throw it down near the Places where they calcine it.

The Mine before it is calcined being exposed to the Air, will moulder in Pieces, and yield a Liquor whereof *Copperas* may be made: but being calcined, it is fit for *Alum*. As long as it continues in the Earth, or in Water, it remains a hard Stone.

Sometimes a Liquor will issue out of the Side of the Mine, which by the Heat of the Sun is turned into natural *Alum*.

The Mine is calcined with *Cinders* of *Newcastle Coal*, *Wood* and *Furzes*; the Fire made about 2 Feet and an half thick, 2 Yards broad, and 10 Yards long. Betwixt every Fire are Stops made with wet Rubbish, so that any one or more of them may be kindled, without prejudice to the rest.

After there are 8 or 10 Yards thickness of broken Mine laid on this Fewel, and 5 or 6 of them so covered; then they begin to kindle the Fires, and as the Fire rises towards the top, they still lay on fresh Mine: so that to what Height you can raise the Heap, which is often times about 20 Yards, the Fires without any further help of Fewel will burn to the top, stronger than at the first Kindling, so long as any Sulphur remains in the Stones.

In calcining these Stones, the Wind many times does hurt, by forcing the Fire in some Places too quickly through the Mine, leaving it black and half burnt, and in others burning the Mine too much, leaving it red. But where the Fire passeth softly and of its own accord, it leaves the Mine white, which yields the best and greatest quantity of Liquor.

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The *Mine* thus calcin'd, is put into Pits of Water, supported with Frames of Wood, and rammed on all Sides with Clay, about 10 Yards long, 5 Yards broad, and 5 Feet deep, set with a Current that turneth the Liquor into a *Receptory*, from whence it is pumped into another *Pit* or *Mine*; so that every *Pit* of Liquor, before it comes to the boiling, is pumped into 4 several Pits of *Mine*; and every *Pit* of *Mine* is steeped in 4 several Liquors, before it be thrown away, the last *Pit* being always fresh *Mine*.

This *Mine* thus steep'd in each of the several Liquors 24 Hours, or thereabout, is of course 4 Days in passing the 4 several Pits, from whence the Liquors pass to the Boiling-House.

The *Water*, or *Virgin Liquor*, oft times gains, in the first *Pit*, 2 Pound Weight. In the 2^d it increaseth to 5 Pound Weight; in the 3^d to 8 Pound Weight; and in the last *Pit*, which is always fresh *Mine*, to 12 Pound Weight, and so in this Proportion, according to the Goodness of the *Mine*, and the well calcining thereof. For sometimes the Liquors passing the 4 several Pits, will not be above 6 or 7 Pound weight; at other times above 12 Pound Weight, seldom holding a constant Weight one Week together. Yet many times Liquor of 7 or 8 Pound Weight produceth more *Alum* than that of 10 or 12 Pound Weight, either thro' the Illness of the *Mine*, or, as usually, the bad calcining thereof. And if by passing the weak Liquor thro' another *Pit* of fresh *Mine*, you bring it to 10 or 12 Pound Weight; yet you shall make less *Alum* with it, than when it was but 8 Pound Weight. For what it gains from the last *Pit* of *Mine*, will be most of it *Nitre* and *Slam*, which poisons the good Liquors, and disorders the whole House, until the *Slam* be wrought out.

That which they call *Slam*, is first perceived by the Redness of the Liquor when it comes from the *Pit*, occasioned either by the Illness of the *Mine*, or, as commonly, the over or under calcining it, as abovesaid; which in the Settler sinks to the Bottom, and there becomes of a muddy Substance, and of a dark Colour. That Liquor which comes whitest from the *Pits*, is the best.

When a Work is first begun, they make *Alum* of the Liquor only that comes from the Pits of *Mine*, without any other Ingredients; and so might continue, but that it would spend so much Liquor as not to quit Cost.

Kelp is made of a *Sea-Weed* call'd *Tangle*, such as comes to London on *Oysters*. It grows on Rocks by the Sea-Side, between High-Water and Low-Water Mark. Being dried, it will burn and run like *Pitch*; when cold and hard, 'tis beaten to *Asbes*, steeped in Water, and the *Lees* drawn off to 2 Pound Weight, or thereabouts.

Because the Country People, who furnish the Work with *Urine*, do sometimes mingle it with Sea-Water, which cannot be discover'd by Weight, they try it, by putting some of it to the boiling Liquor; for so, if the *Urine* be good, it will work like *Yeast* put to *Beer* or *Ale*, but if mingled, it will stir no more than so much Water.

It is observed, that the best *Urine* is that which comes from poor labouring People, who drink little strong Drink.

The boiling *Pans* are made of *Lead*, 9 Feet long, 5 Feet broad, and 2 and

a half deep, set upon Iron Plates about 2 Inches thick, which *Pans* are commonly new cast, and the Plates repaired 5 Times in 2 Years.

When the Work is begun, and *Alum* once made, then they save the Liquor which comes from the *Alum*, or wherein the *Alum* shoots, which they call *Mothers*; with this they fill 2 third Parts of the *Boilers*, and put in one third Part of fresh Liquor which comes from the Pits. Being thus filled up with cold Liquor, the Fires having never been drawn out, will boil again in less than 2 Hours time; and in every 2 Hours time the Liquor will waste 4 Inches, and the *Boilers* are filled up again with green Liquor.

The Liquor, if good, will in boiling be greasy, as it were, at the Top: if nitrous, it will be thick, muddy, and red. In boiling 24 Hours, it will be 36 Pound Weight, then is put into the *Boiler* about a Hoghead of the *Lees* of *Kelp*, of about 2 Penny-Weight, which will reduce the Whole *Boiler* to about 27 Pound Weight.

If the Liquor is good, as soon as the *Lees* of *Kelp* are put into the *Boiler*, they will work like *Yeast* put to *Beer*; but if the Liquor in the *Boiler* be nitrous, the *Kelp Lees* will stir it but very little: and in that case, the Workmen must put in the more and stronger *Lees*.

Presently after the *Kelp Lees* are put into the *Boiler*, all the *Liquor* together is drawn into a *Settler*, as big as the *Boiler*, made of *Lead*, in which it stands about 2 Hours, in which time most of the *Nitre* and *Slam* sink to the Bottom.

This Separation is made by means of the *Kelp Lees*, for when the whole *Boiler* consists of green Liquor drawn from the Pits, it is of a Power strong enough to cast off the *Slam* and *Nitre*; but when the *Mothers* are used, the *Kelp Lees* are needful to make the said Separation.

Then the said Liquor is scooped out of the *Settler*, into a *Cooler* made of *Deal-Boards*, and rammed with *Clay*. Into this is put 20 Gallons or more of *Urine*, more or less according to the Goodness or Badness of the *Liquor*; for if the Liquor be red, and consequently *Nitrous*, the more *Urine* is required.

In the *Cooler*, the Liquor in temperate Weather stands 4 Days. The 2d Day the *Alum* begins to strike, gather and harden about the Sides, and at the Bottom of the *Cooler*.

If the Liquor should stand in the *Cooler* above 3 Days, it would, as they say, turn to *Copperas*.

The Use of *Urine*, is as well to cast off the *Slam*, as to keep the *Kelp Lees* from hardning the *Alum* too much.

In hot Weather the Liquors will be one day longer in cooling, and the *Alum* in gathering, that when the Weather is temperate. In frosty Weather, the Cold strikes the *Alum* too soon, not giving time for the *Nitre* and *Slam* for to sink to the Bottom, whereby they are mingled with the *Alum*. This produceth double the Quantity, but being foul, is consumed in the washing.

When the Liquor hath stood 4 Days in the *Cooler*, then that call'd *Mothers* is scooped into a Cistern, the *Alum* remaining on the Sides, and at the Bottom; and from thence the *Mothers* are pumped back into the *Boiler* again. So that every 5 Days the Liquor is boiled again, until it evaporate or turn into *Alum* or *Slam*.

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The *Alum* taken from the Sides and Bottom of the Cooler, is put into a Cistern and washed with Water that hath been used for the same Purpose; being about twelve Pound Weight. After which it is roached, as followeth.

Being washed it is put into another Pan with a Quantity of Water, where it melts and boils a little. Then it is scooped into a great Cask, where it commonly stands 10 Days, and is then fit to take down for the Market.

The Liquors are weighed by the Troy-Weight; so that half a Pint of Liquor must weigh more than so much Water, by so many Penny-Weight.

XC. *Vitriol* is of several Kinds, being for Colour, *White, Yellow, Green, or Blue*; usually of the two last mentioned: And is made either of *Mineral Waters*, boiled up to a convenient Consistence; then set to *Chrysalize*: Or extracted by common Water out of Earths impregnated therewith. ^{Experiments about Vitriol, Sulphur, and Alum; By .. n. 103. p. 41.} 'Tis also afforded by many sorts of Stones, commonly called *Pyrites* and *Marchasites*, which exposed some Months to *Aerial* Influences, are resolved into Powder, and the *Saline* Part dissolved in Rain or other Water; then boiled and set to shoot, yield store of *Vitriol*, especially with the Addition of *Copper* or *Iron*. It is often associated with Earth and Stones, wherein Metals are contained; and with many natural Recrements of Metals, such as *Misy*, *Sory*, *Chalcitis*; from which 'tis usually separable by the common method with water, sometimes not to be extricated until the *Mineral* be first calcined or burnt. It is also frequently found pure and perfect in the Caverns of the Earth, being an *Efflorescence* of several *Minerals*; and this is accounted by all *Naturalists*, the best, both for *Medicinal* and *Spagyric* Uses. Lastly, it is copiously contained in common *Mineral Sulphur*.

Vitriol consists of *insipid Phlegm*, *Earth*, or *Oker*, some *Metal*, *Mineral*, *Sulphur*, an *Acid Salt* or *Spirit*, together with some small Portion of the *Volatile Aerial Salt*. That it contains Water, needs no great Proof, since no *Saline* Substance can *Chrysalize* without it; and *Distillation* will convince any Person, that it exceeds in Quantity any of the other Principles.

The *Earth* or *Oker* may be thus separated. Dissolve *Vitriol* in fair Water, immediately a yellow Powder will separate, and in a short time subside. The greater the Quantity of Water imployed, the more *Oker* precipitates: The weaker the *Lixivium*, the less able to support Bodies more ponderous than common Water; and the lighter the Water (as if distill'd Rain-Water, or *Phlegm* of *Vinous Spirits*) the more *Earthy* Parts subside, upon the same *Hydrostatical* Principle. I have above 20 times repeated this Dissolution, seconded by *Filtration* and *Coagulation*, and each time separated some Quantity of this Earth: And I am persuaded, had I long continued the Operation, the Success would have been the same, only I observed the Quantity separated each time, sensibly to diminish. But I have found a more easy and expedite way of effecting this Separation: Take a good Quantity of the common *Dantzick* or *Hungarian Vitriol*; having powder'd it, put it into a slender *Cucurbite*; place it in Water, keep under it an equal constant Fire 3 or 4 Days: The *Vitriol* will, without Addittament, become fluid,

fluid, as if dissolved in *Water*, and the *Oker* with most of the *Metalline* Parts, with the gross *Sulphur*, will subside, and become a hard Cake at the Bottom, the *Vitriol* being fluid about it, which in the Cold again *Chrystallizeth*; excepting a small Quantity of *Liquamen*, of the same nature with that we shall hereafter mention. This repeated once or twice, the *Vitriol* attains unto a high degree of Purity, and is easily capable of many Alterations, whereunto it was not subject before this Purification. This Operation will not succeed in a dry Digestion; I mean, *Ashes*, *Sand*, *Filings* of *Iron* or *Steel*, open Fire, or even Flame of *Lamps*, whether fed with Oil or Spirit of *Wine*. This *Earth* may be also obtained in a great Proportion, though in another Form, if after a long and intense *Calcination*, the *Vitriol* is freed from its remaining Salt, by frequent *Ablutions* with warm *Water*: The far greatest part of this *Dulcify'd Colcothar* is *Insipid Earth* with some small Proportion of *Metal*. The same may be precipitated by Salt of *Tartar*, or any other *Alkalies*, or *Filings* of *Zink*, or other immature *Minerals*, out of a Solution of *Vitriol* in common *Water*. It being also separated from *Metalline* and *Saline* Parts, by a Method I shall hereafter mention, there remains a great Quantity of an *Insipid Substance* nearly resembling *Burnt Alum*. Besides, whereas *Salt*, *Nitre*, &c. require in *Distillation* a large Quantity of *Earthy Substance* to disjoin the *Saline* Parts, and prevent *Fusion*; *Vitriol* and *Alum* need it not: an unquestionable Proof, that *Earthy* Parts abound therein.

That *Vitriol* contains *Sulphur*, is evinced by the sulphureous Smell it emits in *Distillation*, especially if urged with a strong Fire from the Beginning; and the Spirit thus drawn being rectified, the Liquor, which first rises, hath a highly sulphureous Smell; as hath also that we shall hereafter mention, distilled from *Vitriol* deprived of its *Metallick* Parts. The *Colcothar Dulcified*, or *Metallick* Parts precipitated by an *Alkali*, or *Immature Mineral* sublimed with *Sal Armoniack*; an *Inflammable Sulphur* may be many ways separated, both from the *Sublimate* and *Caput Mortuum*. The common Oil of *Vitriol* digested on *Antimony*, then distilled, yields a much greater Quantity of *Sulphur*, than would have been produced, had any other *Acid Liquor* been employed; and the same Oil of *Vitriol* digested with Spirit of *Wine*, and distilled, yields an Oil, and at the latter End, store of sulphureous inflammable Flowers.

As for the *Acid Saline* Principle, I suppose no Person who hath tasted of the Spirit of *Vitriol*, and that abusively called its Oil, will question its abounding in that Subject.

In order to the Resolution of some Enquiries about the *Saline* Principle, I made these Experiments. I took 4 or 5 Gallons of the *Vitriolate Water*, which was conveyed by artificial Channels at *Deptford*, from the Beds of *Pyrites* or *Marchasites* into the great Cistern. I distilled therefrom, in Glass Vessels, two Thirds of *insipid Water*; letting the Glasses cool, the *Water* let fall a *Vitriol* of a lovely dilute Colour, together with a great Quantity of that yellow Sediment which we formerly call'd *Oker*. Then evaporating a third Part of the remaining Liquor, I received more *Vitriol* of a paler Colour than the former, and *Oker* as before, though less. The 5th time this

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Operation was repeated, instead of *Vitriol* it afforded a Yellow, and ever after a *White Salt*, which did differ exceedingly from *Vitriol*, not only in Colour, but also in Taste, being fiery and pungent; and did partake little of that abominable rough astringent Smack, which is peculiar to *Vitriol*. It was also *Unctuous*, like Salt of *Tartar*, made the Hands soft and supple, cleansing like a *Sapo*, whereas common *Vitriol* renders them rough and harsh: Being dissolved in *Water*, it appeared to the very Eye very *Fatty* and *Oleagenous*.

From 5 Pounds and an half of *Lixivium*, I received 4 Pounds of this fiery *White Salt*, besides half a Pound of *Liquamen*, which remained fluid, and would not coagulate. I do the rather mention this, for that it is one of the most eminent Instances, I ever met withall, of so great a Quantity of Salt kept fluid in the Cold, by so small a Quantity of *Water*.

The remaining *Liquamen* was very fiery, acidly pungent, and extremely ponderous; no whit inferiour, in my Opinion, in any of these Respects to common Oil of *Vitriol*: it seeming to me strange and unusual, that so strong a Liquor should be obtained without any considerable degree of Fire.

This *Liquamen* being exposed to the Air, soon attracted double its Quantity of Moisture: I cannot recollect, that I did ever observe any fluid Body, which approached near unto it for this Property; though I am not ignorant, that all *Corrosive Saline* Liquors will borrow considerably from their neighbouring Element. I always observed this *Liquamen* to acquire more or less Moisture, according to the Constitution of the Season, rising sensibly in moist Weather, and little in dry.

The white Salt, last mentioned, was distilled in a Sand Furnace, and the far greater Part came over in the Form of a Spirit highly *Acid*, especially that which came last in small Drops. This Liquor rectified in a very tall Body immediately upon the Approach of the smallest Degree of Heat, a *Volatile Sulphureous* Spirit did arise as clear as Rock Water, almost, nay I think altogether *Insipid*; yet the Smell so subtle and penetrating, that 'twas insupportable: And such it continued many Years, not letting fall any Sediment, and thereby losing its strength, as doth the *Volatile Spirit* made out of common *Vitriol*. The Spirit which remained after the Separation of the more *Volatile*, was in all Respects like that of *London Vitriol*; only seemed more gratefully *Acid*, and might, like it, be separated into Spirit and Oil, corruptly so stiled.

Vitriol freed, as is before declared, from its *Earthy* and *Metallick* parts, by Zink, or other *Imperfect Minerals*, is much of the same Nature, and yields its Spirit in Sand, as this we have now mentioned; is also White, and more *Unctuous*; hath a Grain more like *Nitre* than *Vitriol*, as hath also the *Goslar Vitriol*, which is White, and comparatively *Unctuous*, because it hath little Metal, and less *Mineral Sulphur* than the common; whose *Metaline* Part detains the *Saline*, and will not dismiss it until long urged by a very intense degree of Heat. What remained in the *Retort* after this *Distillation*, was not red or purple, like the *Caput Mortuum* of the common *Vitriol*, but *White*, *Light*, and *Spongious*, like *burnt Alum*, and altogether as *Insipid*; although, after

after it was some time exposed to the *Air*, it received many strange Impressions and Alterations.

n. 104. p. 66. I cannot but take notice here of the great Affinity that is between *Vitriol*, *Alum*, and *Mineral Sulphur*; the *Saline Principle*, which is in each of them by far the chief, both in Quantity and Energy, having one Nature and the same Properties. This will appear evident to those who will compare with the common Spirit, or Oil of *Vitriol*, the *Acidity* of *Sulphur* afforded by Brimstone inflamed under a Glass Bell; which being rectify'd, is not to be distinguish'd, by any sensible Property, from the well *Rectified Acidity*, or Oil of good *Vitriol*; and they may, I am confident, be safely substituted for each other, producing in Men and Metals the very same Effects, being in my Apprehension no less alike in their internal and secret, than in their external sensible Qualities.

The Quantity indeed of *Acidity*, which is obtained in the ordinary Ways of Operation, is very small, a Pound of Brimstone not yielding above one Ounce or 10 Drams, the far greater Part being by the rapid Motion of the Flame sublimed in the Form of *Flores*, which differ not from the common *Flowers*. I have been often assured by a Kinsman of that admirable Mechanist *Cornelius Drebbel*, that his Uncle did, by the means of conveniently shaped Vessels, ordinarily obtain out of a Pound of good Brimstone, 8, and in a very moist Season, 10 Ounces of *Acidity*; and was confident, he could, by improving the Contrivance, recover the entire Weight of the *Sulphur*; the Moisture of the Air acquired, making abundant recompence for the Avolation of what is *Incoagulable*. I have my self by the means of several *Menstrua*, reduced common Brimstone into the Form of an highly *Acid Corrosive Liquor*, and even Spirit of *Nitre*, or *Aqua-Fortis* well rectified, being digested on the *Flowers* of *Brimstone*, then distilled in Ashes; this repeated 5 or 6 times, after the last *Cohobation* there will remain with the Flowers near their Weight of an *Acid Spirit*, like that made by a Bell; the Spirit of *Nitre* being scarcely changed from what it was before the Operation. And I suppose that being reiterated frequently, especially if fresh Spirit be employed, the whole may be transmuted; abating some few Earthy and Metallick Particles, the Sulphureous being capable of a fluid Form, and are copious in Oil, in *Vitriol*, *Aqua-Fortis*, and many other *Acid Menstrua*, especially if any imperfect Sulphureous Minerals were employed with the other Ingredients in their Production.

I once made out of *Vitriol*, common Salt, and *Antimony*, a Liquor clear as any Fountain Water, yet the Smell intolerably Sulphureous, continuing so many Years: And true inflammable Sulphur may several ways be recovered out of Oil of *Vitriol*, or Sulphur, many times rectified and in appearance free from such Mixture. We formerly mentioned its Separation by means of *Vinous Spirits*; also if mixt with Oil of *Turpentine*, and distilled, at the latter end store of Brimstone will sublime: I suppose none will ascribe this to the Vegetable Oil, which is only the means of its Separation, being an appropriate *Menstruum* or Dissolvent of sulphureous Bodies. This recalls into my Mind what I have often observed, (and I suppose it always happens) in the Preparations of Balsam of *Sulphur* with the said Oil of *Turpentine*;

pentine: After the Oil is satiated with *Sulphur*, it lets fall store of fair *Chrystals*; an evident Proof of its *Saline* Nature. For although these *Chrystals* broken, within appear full of *Sulphur*, their outward Parts or Superficies seem perfect Salt, by virtue whereof they are disposed to *Chrystallization*. It may indeed be objected, that *Chrystallization* is not a sufficient Proof of a *Saline* Nature, the *Essential Oils* (as they are called) of *Anniseeds*, *Fennel-Seeds*, and of many other Substances being very prone to *Chrystallize*. But most *Essential Oils* abound no less with Salt than common *Sulphur*, into which I have often converted them without additament or suspicion of *Transmutation*.

The *Affinity*, I had almost said *Identity* of the *Saline* Principle in *Sulphur* and *Vitriol*, further appears by the following Experiment. Take thin Plates of *Copper*, cement them carefully with common *Brimstone*, *Stratum super Stratum*, repeat the Operation 4 or 5 times with fresh *Sulphur*; most of the *Copper* will be converted into *Vitriol*, which dissolved in *Water*, and most of that evaporated, yields very beautiful *Azure Chrystals*. The same may be effected with *Iron*. Or, take the *Acidity* of *Sulphur* (corruptly call'd its Oil) moisten therewith Filings of *Copper* or *Iron*; then free them by *Fire* or *Air* from superfluous *Moisture*, repeat this twice or thrice, and afterwards with common *Water* you may extract a fair *Vitriol*, which by the Chymists is called *Vitriolum Martis* or *Veneris*; according as the one or other Metal was employed in order to its production: which same Metals being dissolved in any *Acid Menstrua*, and chrySTALLIZED, are converted into *Vitriol*. This is signified unto us by the common Name of *Vitriol*, Alonso Barba's Art of Metals, Lib. I. vulgarly stiled *Cuperosum*, quasi *Cuprum Erosum*; that being the Metal wherewith 'tis usually associated. *Sulphur* indeed is found mixt with most Metals and Minerals, *Gold* and *Silver* not being excepted, the most expert Mineralists in *Peru* accounting abundance of *Sulphur* an especial sign of rich *Ore*: And among the richest *Ore* of the Mountain of *Potosi* are such quantities of *Brimstone*, that the Cavities and hollow Places are presently filled with *Flame*, if a *Candle* touch or come near their Sides. Yet they do not ordinarily find *Vitriol* in Mines of *Gold* and *Silver* (unless mixed with other Metals) because those Bodies are something too compact for the *Sulphureous Spirit* to dissolve, assisted with a small degree of *Heat*; whereas all *Ores*, which touch on *Copper* or *Pyrites* abounding in *Sulphur*, do also afford *Vitriol*, *Copper* being an open Body, and more easily soluble than any other Metal; for it will presently, though crude, dissolve in, and give a deep Tincture to common *Volatile Urinous Spirits*: which cannot be affirmed of any other Metal, howsoever prepared; and therefore no wonder if it be not by the Steam of *Sulphur* so easily converted into *Vitriol*. And in the Bowels of the Earth it is, I do conjecture, mostly produced after this manner; an *Acid Salino-Sulphureous* Steam (such we have proved that of common *Sulphur* to be) insinuating it self into a Vein of *Copper*, corrodes it, and uniting therewith, becomes *Vitriol*. So it doth by mixture with *Iron* and other Minerals; whence being washed with *Water*, it produces *Acidulae* of divers kinds, according to the Nature of the Minerals wherewith the *Acid* is united. And that *Vitriol* and *Vitriolate Waters* are thus produced, is hereby

confirmed, that many *Ores* and *Pyrites* being distilled *per Descensum*, yield abundance of common *Sulphur*: The Remainder, thereafter affords store of *Vitriol*, although before Calcination it would have yielded none; the Fire enabling the *Sulphur* to corrode, and associate with the *Metallick* Parts, that which is without mixture of *Metal*, or which hath thereof a very small Proportion, continuing under the form of Brimstone.

This to me seems the Reason, why *Vitriol* and Brimstone are usually found together; those Minerals and *Pyrites* that abound with one, being usually impregnated with the other: *Vitriol* not being a distinct Principle, but the genuine Offspring of *Sulphur*, its material Cause; and Fire and Air, the efficient Causes of its Production.

I speak of *Vitriol* generated in the Bowels of the Earth; for it may be, and is often, produced above Ground, by the *Aerial Salt* united with Mineral Substances copiously contained in *Marchasites*, which it extricates, and coagulating therewith becomes a *Vitriol*. This *Aerial Salt*, which I have many ways procured, whilst in the Air, is altogether unspecificate, I mean freed from all Union with, or Determination by, any seminal Principles, (the *Primordials* of all *Species* in the Universe being in my Opinion *Spermatical*) but being once at the Command of the *Architectonick* Power of any Species, whatsoever that be, it is by it, with other Matter, determined in order to the Formation and Augmentation of the *Individuum*, and Propagation of the Species, and upon the Dissolution of its Dwelling, returns whence it descended. Besides this, there is also in the Air an *Acidity*, as is evident in *Iron Bars*, whose Superficies is thereby resolved into a subtile *Crocus*; also in the Tarnishing of *Polish'd Metals*, where Pit-Coal is much burnt, near unto and on the Sea, and where exposed to certain Winds.

This *Acid Spirit*, with the Salt last mentioned, are Instruments by Nature employed in almost every Operation; especially the Salt, without which no perfect Animal can subsist a Minute, and all Vegetables deprived thereof, do immediately decay. It's well known that several Minerals and *Pyrites*, which are to the Taste altogether insipid and elixivated, and would yield not a Grain of Salt, being exposed to the Air are resolved into a Powder, and afford some *Alum*, others *Vitriol* copiously. Sometimes the Minerals require previous Calcination, which opens and relaxes the Compages of the Bodies; so that the Air may have more easy ingress. And it is, I think, by most allowed, that after all the Salt is extracted out of Earth impregnated with *Vitriol*, *Alum* or *Nitre*, the said Earth being exposed a sufficient time unto the Air, acquires fresh Supplies: which must be derived from the Air. And it is particularly remarkable in *Vitriol* and *Alum*, that their Spirit being put into a Commotion or Fermentation by either Heat or contrary natur'd Spirits, the Glasses which contain them being well closed, although large and strong, will be cracked or broken in pieces; which seems to proceed from the Expansion of some of those prodigiously active springy Particles, wherewith the Air abounds, which together with the *Aerial Salt* were arrested by the vitriolifying Principle, and set at liberty by the cumulating

multuating Liquor, the change of whose Contexture might occasion their Dismission, the unbending of their Springs, and the Effects which thereupon ensue.

The Affinity between Vitriol and natural, not factitious, Alum, thus appears. Vitriol not only in *England*, but in several other Parts of the *World*, is ordinarily found in the same Vein, and sometimes in the same Parcel, which yields the Alum: which may by several Methods be separated from each other. The Mineral of Alum, if mature, *Elixiviated* yields its Salt presently; if less mature, it requires previous Calcination; if very immature, it must not only be burnt, but long exposed unto the Air.

The Cause whereof seems the very same with that we lately mentioned in our Account of the Production of Vitriol; the Alum, as that is, being produced by the *Sulphur's* acting on, corroding of, and coagulating with, some mineral Substance, which usually partakes more of a *Terrene* and *Stony*, than *Metallick* Nature: although yet Metal is often found to be contained in the Alum-Stone or *Ore*. And that the *Sulphur* is the chief efficient and material Cause of its Production, appears from hence, that many Alum-Stones (as the Vitriolate) distill'd *per Descensum*, yield good Brimstone; and all Alum-Stone or *Ore*, during Calcination, emit a *Sulphureous* Steam. An inquisitive Naturalist of my Acquaintance did gather from the very same Rock, and that within a few Inches of each other, Vitriol, Alum, and *Sulphur*, all of them excellent and perfect in their Kind. Indeed they are so nearly allied, that I can by some pretty Artifices (too long to be here described) convert *Alum* into *Vitriol*, or *Vitriol* into *Alum*, which shall be the same, to all Intents and Purposes, (as we commonly speak) with the *Natural*.

Alum distilled into an *Acid Spirit* with Copper or Iron, becomes good Vitriol; and Vitriol freed from its metallick Parts, becomes *Aluminous*; and distill'd, yields a Spirit scarcely to be distinguish'd, not only by Taste, but even by the nice and accurate Scrutiny, from that of Alum. And (which doth in some measure illustrate this *Affinity*) I have often observed rectified Oil of Vitriol and Spirit of Sulphur to coagulate, and become solid transparent Concretions, exactly resembling Alum chrySTALLIZED, with which compared, I am confident, the most judicious Eye, without the assistance of the Palate, would find little difference.

The Salt in *Brimstone* is thus derived. *Brimstone* consists of *Mineral Sulphur* and an *Acid Salt*, which being united, it is no difficult matter to conceive how it should become *Volatile*, if we reflect on *Cinnabar* and *Sublimate*; in one, *Mercury* is so disguised by a little *Sulphur*, that it seems a *Mineral* Substance of another nature, and abating the Colour, not unlike *Antimony*; in the other, Salts very acid and fixt are rendered sufficiently volatile. Now whence the *Brimstone* should derive its sulphureous Particles, will appear very obvious to them, who have observed how much the Bowels of the *Earth* abound with *Bituminous* Substances. What else feed all the *Subterraneous Fires*? What an immense Quantity thereof is lodged in the *Earth*, will be attested by our large and Numerous *Coal-Mines*, and by those Eruptions of *Bituminous* Substances in many Quarters of the *World*; among which that

call'd *Naptha*, is so purely sulphureous, so free from Mixture with any other Materials, that upon the very Approach of Fire or Flame, it is immediately inflamed, and scarcely to be extinguish'd until wholly consumed. As for the saline Principle of *Sulphur*, I conclude it to be common *Salt*, which, together with the *Aerial Salt* before mentioned, is the Foundation of all *Saline* Substances in the Universe. And I assure you, I can with common *Salt* make both *Vitriol* and *Alum*, hardly distinguishable from the natural.

The Efflorescence of certain Mineral Glebes, by Dr. Lister. n. 110. p. 221.

XCI. I kept by me certain big Pieces of *Crude-Alum Mines*, such as it was taken out of the Rock ; I had also in the same Cabinet like Pieces of the ordinary *Fire-Stone*, or *Marchasite* of the Coal-Pits, which here we call *Brass Lumps*.

In Process of Time, both the Glebes shot forth *Tufts* of long and slender Fibres or Threads ; some of them half an Inch long, bended and curled like Hairs in both these Glebes : these *Tufts* were in some measure transparent and chrystalline. These *Tufts* did as often repullulate, as they were struck and wiped clean off.

The *Aluminous Fibres* were of a *Taste* very *Alumy*, and pleasantly pungent : The *Vitriolick*, *Stiptique* and Odious. Again, the *Alum* ones, being dissolved in fair Water, raised a small *Ebullition* : Whereas the *Vitriolick Fibres* dissolved quietly. The *Alum Fibres* were generally smaller, and more opaque, Snow-like. The *Vitriolick* larger, many Fibres equalling an Horse-Hair in thickness, and more *Chrystalline*. The Water wherein the *Alum Fibres* were dissolv'd, did give no red Tincture with Gall, not by all the means I could devise to assist them : the *Vitriolick* did immediately give a *Purple Tincture* with Gall.

Having laid Pieces of the same *Marchasite* in a Cellar, they were in a few Months covered over with green *Copperas*, which was these Fibres shot and again dissolved, by the moist Air, clodder'd and run together. Exposing other Pieces of the same vitriolick Glebe in my Window, where the Sun came, they were covered over with a white farinaceous Matter ; that is, with these Fibres calcined by the Rays of the Sun and warm Air, beating upon them.

I take these fibrous and thread-like Shootings of *Alum* and *Vitriol* to be most genuine and natural, and their angular Shootings, after solution into *Cubes* and *Rhomboides*, to be forc'd and accidental ; *Salts* of very different Natures, as well vegetable as fossile, by a like Process in chrystallizing of them, being observed to shoot into like Figures.

Amianthus,
By . . . n. 72.
p. 167.

XCII. 1. Signior *Marco Antonio Castagna*, Superintendant of some Mines in *Italy*, hath lighted, in one of them, upon a great Quantity of that lanuginous Stone called *Amianthus*, which he knows so to prepare as to render it like either to a very white *Skin*, or to a very white Paper ; both which resists the most violent Fire. The *Skin* was covered with kindled Coals, whence it took flame ; but being taken out, after it had been left there a while,

while, the fiery Colour presently disappeared, and it became cold and white again as before; the Fire it seems passing only through, without wasting or altering any thing of it: whereas some of the hardest and solidest Metals, as *Iron* and *Copper*, reduced to very thin Plates, and kept as long in the Fire as this Substance was, would cast Scales. Again, this Skin being made as thin as Paper, doth not only yield that ancient and so much admired *Amianthus*; but is also perfecter than that which comes from *Cyprus*, and not inferior to that which sometimes, though but seldom, comes out of *China*. This Paper was also try'd in the Fire, and there it remain'd likewise without any visible detriment, or without the least change of its first whiteness, fineness or softness. Of the same Matter this Artist hath wrought a Wick, never to be consumed as long as 'tis fed, nor altering its Quality after the Aliment is wasted away.

2. The *Lapis Amianthus*, or *Linum Fossile Asbestinum*, is found in no small Quantity in *Llan-Fairyrng Hornwy* in the Northern Part of *Anglesey*, where it runs in Veins through a thick Stone, in hardness and colour not unlike Flint. These Veins are generally about $\frac{1}{4}$ of an Inch deep, which is the length of the *Amianthus*, and is seldom longer, but often shorter. It is composed of a lanuginous Matter, exactly resembling that of pappous Plants; but so closely compact, that till you draw a Pin, or any such sharp thing, cross the Grain of it, it appears only a shining Stone, there being not the least Filament of Lint to be perceived in it. In its natural Form, some of it looks whitish, and some straw-coloured, but all shining; but if pounded in a Mortar, the Brightness disappears, and the whole becomes whitish. Note, that above and beneath the Veins there is a very thin *Septum* of terrene Matter, betwixt the *Amianthus* and the Stone whereto it adheres. I put a small Quantity of the Lint in the Fire, which grew red-hot; but tho' it remained there $\frac{1}{4}$ of an Hour, I could not perceive that it was any thing consumed. I twisted also some of it in the Form of a Wick, and dipping it in Oil, it gave as good a Flame as other Wicks, till the Oil was consumed, the Wick remaining of the same Proportion as at first. Being satisfied it was incombustible, I pounded some quantity of it in a stone Mortar, till it became a downy Substance: then I sifted it thro' a fine Searce, by which means the terrene Parts (being reduced to a Powder) came thro' the Searce, the *Linum* remaining. I then brought it to a *Paper-Mill*, and putting it in Water in a Vessel just capacious enough to make Paper with such a Quantity, I stirred it pretty much, and desired the Workmen to proceed with it in their usual method of making Paper, with their *Writing-Paper Mould*, only to stir it about ever before they put their Mould in, considering it as a far more ponderous Substance than that they used; and that consequently if not immediately taken up after it was agitated, it would subside. Paper thus made of it, proved but very coarse, and too apt to tear: But this being the first Trial, I have some reason to believe it may be much improved.

By Mr. Edw. Lloyd, m.
176. p. 923.

XCIII. I here send you the Account of the *incombustible Linnen Cloth*, which I received from one *Conco*, a natural *Chinese*, Resident in the City

Incombustible Cloth, by Mr. Nic. Wasse.
m. 178.
p. 1049.

of

of *Batavia* in the North-East Parts of *India*, who by means of *Kedyarear Sukradana* (likewise a *Chinese*, and formerly chief Customer to the old *Sultan* of *Bantam*) did after several Years diligence, procure from a great *Mandarin* in *Lanquin*, (a Province of *China*) near $\frac{1}{4}$ of a *Yard* of the said Cloth; and declared that he was credibly informed, that the *Princes* of *Tartary*, and others adjoining to them, did use it in burning their *Dead*; and that it was said and believed by them, to be made of the under part of the Root of a Tree growing in the Province of *Sutan*, and was supposed, in like manner, to be made of the *Todda Trees* in *India*; and that of the upper part of the said Root near the Surface of the Ground, was made a finer Sort, which in 3 or 4 times burning, I have seen diminish almost half. They report also, that out of the said Tree there distills a Liquor, which not consuming, is used with a Wick made of the same Material with the Cloth, to burn in their *Temples* to Posterity.

By . . . ib.
p. 1050.

2. A Handkerchief, or Pattern of this *Incombustible Linnen*, which was shewn the *Royal Society*, was a Foot long, and just half a Foot broad.

There were 2 Proofs of its resisting Fire, given at *London*, one before some of the Members of the *Royal Society* privately, Aug. 25. 1684. when Oil was permitted to be poured on it whilst red-hot, to enforce the Violence of the Fire. Before it was put into the Fire this first Trial, it weighed one Ounce, six Drams, sixteen Grains, and lost in the burning 2 Drams, 5 Grains.

The second Experiment of it was publick before the *Society*, November. 12. following, when it weighed (as appears by the Journal of the *Society*) before it was put into the Fire, 1 Ounce, 3 Drams, 18 Grains. Being put into a clear Charcoal Fire, it was permitted to continue red-hot in it for several Minutes: When taken out, though red-hot, it did not consume a Piece of white Paper on which it was laid. It was presently cool, and upon weighing it again, was found to have lost 1 Dram, 6 Grains.

Decem. 3. Mr. *Arthur Baily*, one of the Fellows of the *R. S.* presented them with a Piece of this Linnen in the Name of Mr. *Waite*. At the same time, the same Mr. *Baily* presented Dr. *Plot* with another Piece of it, which being brought to *Oxford*, the Experiment was again repeated on it, Decem. 16. it being put into a strong Charcoal Fire, in the *Natural History School*, in a full meeting of the *Philosophical Society* of that *University*, where after it had continued red-hot for some considerable time, it was taken forth again little altered when cold, saving that it seemed a little whiter and clearer than before.

By Dr. Rob.
Plot, ib.
p. 1051.

3. This kind of *Linnen Cloth* was esteemed by the Ancients, though then more common, and perhaps better known, than 'tis yet amongst us, equally precious with the best of *Pearls*.

Nor is it now of mean Value even in the Country where made, a *China Cover*, (i. e. a Piece 23 Inches and $\frac{1}{4}$ long) being worth 80 *Tale*, i. e. 36 *l* 13 s. 4 d.

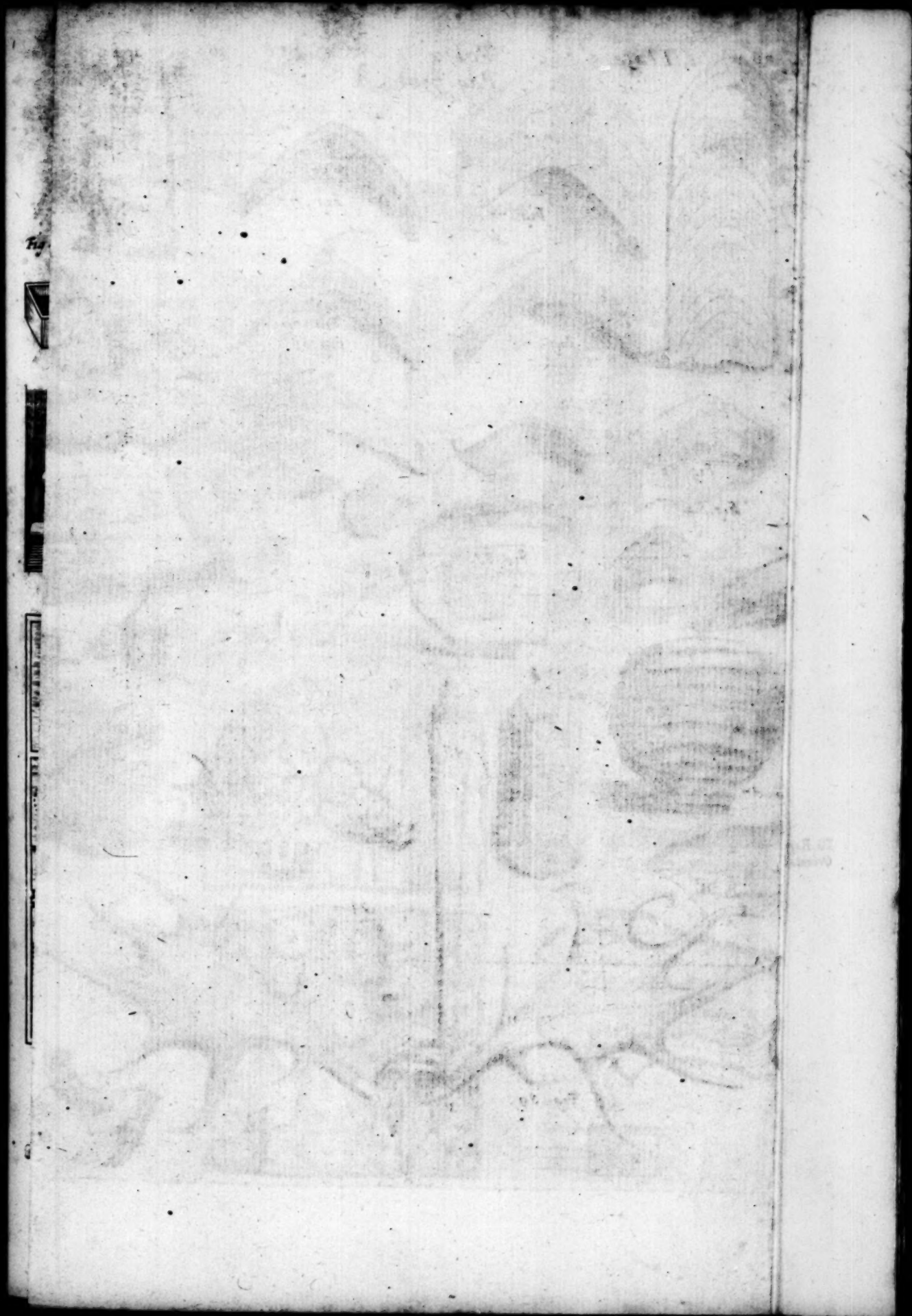




Fig. 68.

Fig. 67.



Fig. 74.



Fig. 75.

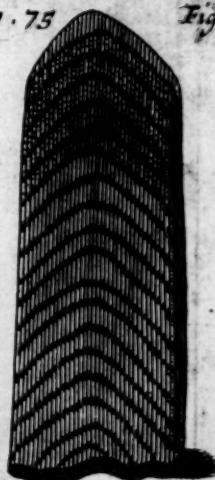


Fig. 76.

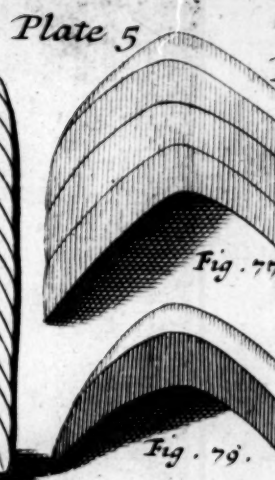


Fig. 77.

Fig. 79.

Fig. 65.

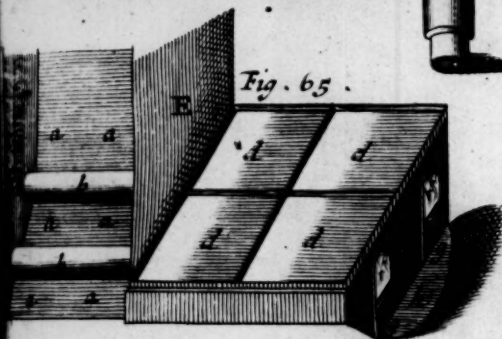


Fig. 85.



Fig. 82.



Fig. 84.



Fig. 81.



Fig. 83.



Fig. 88.



Fig. 66.

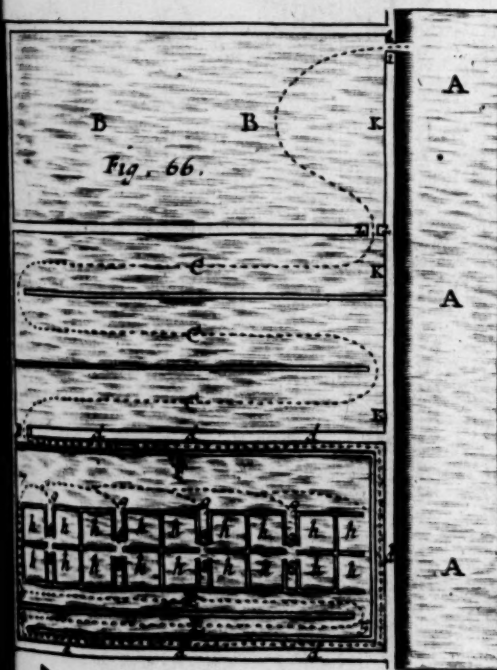


Fig. 71.



Fig. 70.



Fig. 72.



Fig. 87.



93 I

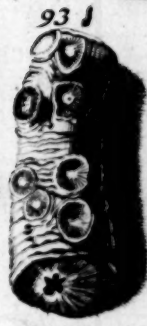


Fig. 73.

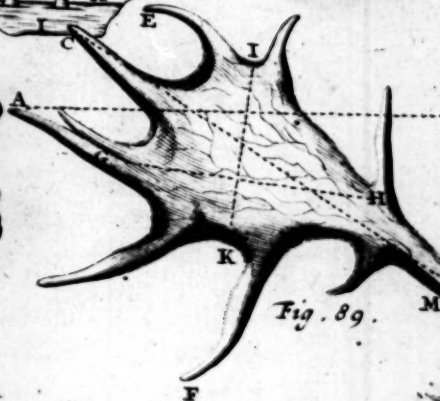
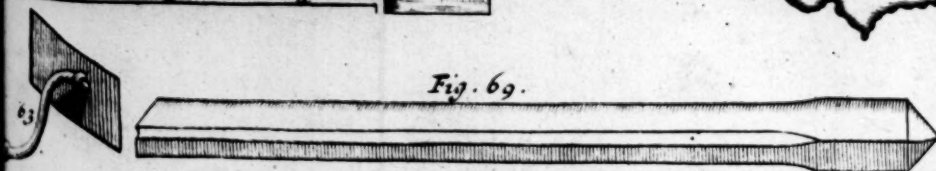
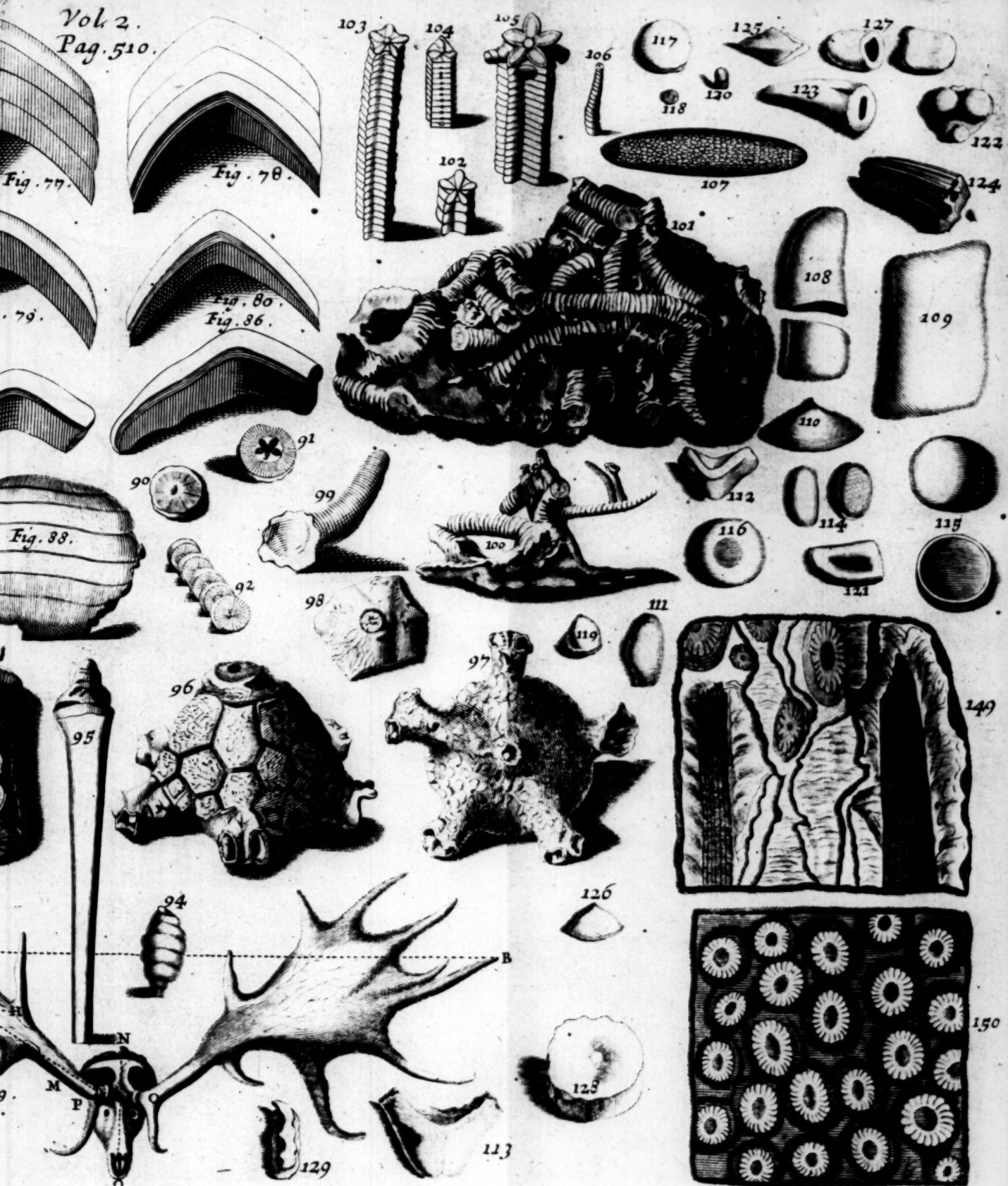


Fig. 89.

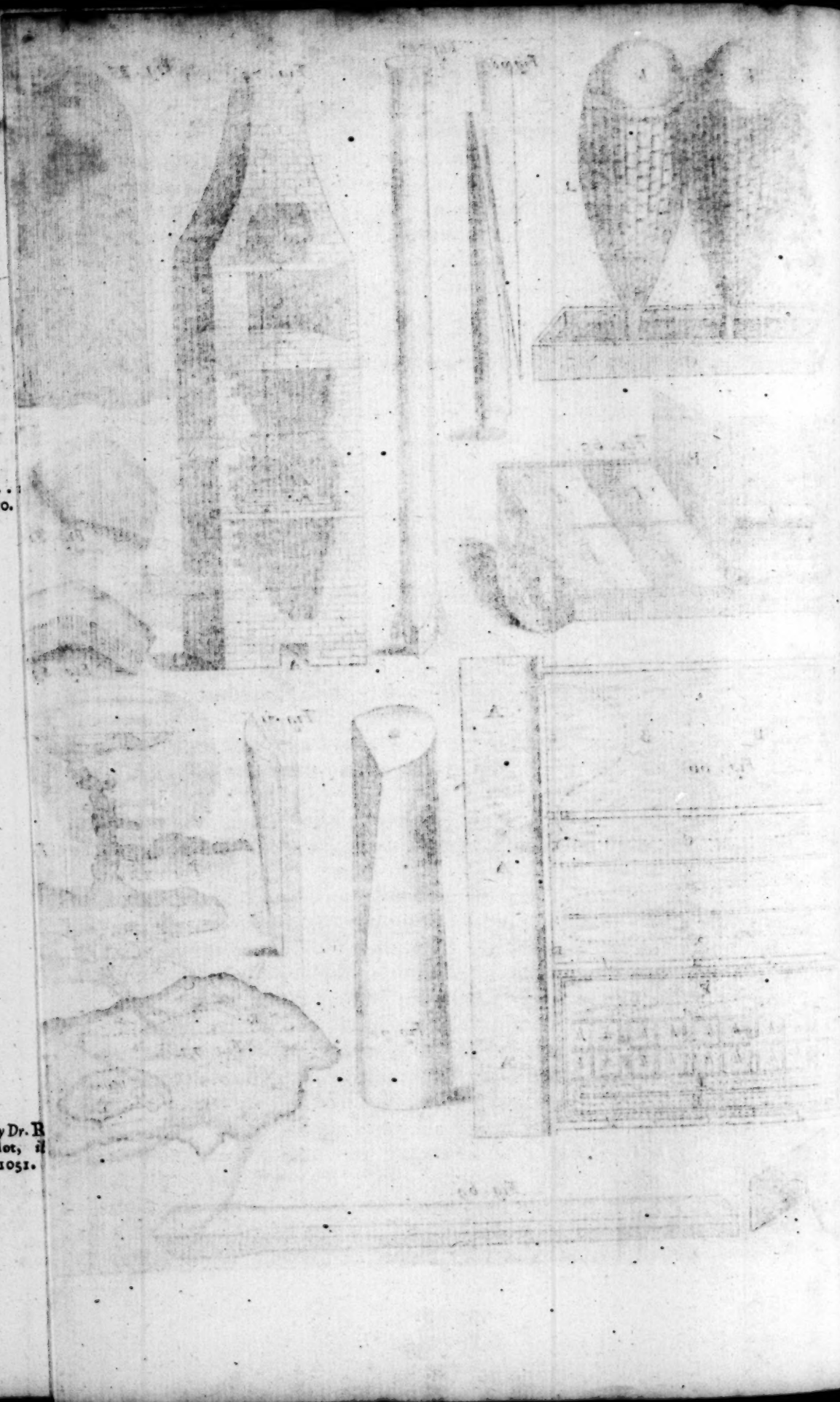
Fig. 69.





By...
p.1050.

By Dr. R.
Plot, il
p.1051.



The *Reality* of such a Being has been doubted, or deny'd by very good Authors: Who though they owned such a Mineral as *Amianthus*, out of the woolly Part whereof, this sort of Linen was always anciently said to be made, yet questioned the Possibility of its having been actually done. But *Pliny* says expressly (and I dare believe him in any thing he speaks of his own Knowledge) that he himself had seen *Napkins* thereof, which being taken foul from the Board at a great Feast, were cast into the Fire, by which means they were better scoured, and looked fairer and cleaner than if they had been wash'd in water.

And besides the Testimony of several curious Persons in all Ages, we have now seen a Piece of this Linen pass the fiery Tryal both at *London* and *Oxford*.

This lanuginous Mineral is called from its strange Qualities, sometimes *Amianthus*, quod in Ignem injectus non *mutatur*; the Fire being so far from defiling it, that it rather gives it a Lustre.

2. It is called *Asbestos*. And,

3. *Salamandra*, in *English*, *Salamander's Wool*: I suppose from the *Tbryallides*, or *Candle-Wicks*, said to be anciently made of it, which being put into Lamps of *inconsumable Oil*, would never waste or go out; which I take to be the true reason of the Imposition of these Names upon it, whether there ever were any such Lamps or no.

4. From a pungent Quality, *Agricola* says, it has on the Tongue without *Astringency*, it is called *Alumen*, having the distinguishing Epithet *Plumeum* added to it, taken from its downy Filaments, to discriminate it from all the rest of the *Alums*.

5. From the light gray Colour of its lanuginous Parts, it is called by some *Polia*, by others *Corfoides*; and from its likeness to the hoary Fibres of some sort of *Mat-Weed*, *Spartapolia*.

6. From the Capacity it has of being spun into Thred, it is also called *Linum*, with some distinguishing Epithet taken either from its Quality, such as *Asbestinum*, or *Vivum*; or from the Place where found in general or particular: It being called in general *Linum Fossile*; in *English*, *Earth-Flax*; and in particular, *Linum Indicum*, *Creticum*, *Cypricum*, & *Carpasium*, or *Carystium*. But beside the Places that have given these Epithets to the Head made of it, it is also found in *Tartary*, at *Namur* in the *Low-Countries*, at *Bisfield* in *Thuringia*; amongst the *Mines* in the old *Noricum*; somewhere in *Aegypt*; and in the Mountains of *Arcadia*; also at *Puteoli*, and lately in some *Mines* in *Italy*; and it has been yet latelier met with in a small I and belonging to *William Robins* Esq, called *Ynis Molromind*, i. e. the Island of *Sea-Calves*, in the Parish of *Llan-Fairing Hornwy* in *Anglesea* in *Wales*.

It is commonly by the *Lithographers* reckoned among Stones, but I rather should judge it a *Terra Lapidosa*, or middle Substance between a Stone and an Earth. But whether the one or the other, it is made of a Mixture (I guess) of some Salt or other, a pure Earth without Sulphur, coagulated in the Winter, and hardened to Perfection by the Heats in Summer; which Salt *Johannes Hefus* proves by a very cogent Argument to be *Alumen Liquidum*,

quidum, describing it as *Matthiolus* also does, to be of a whitish lacteous Substance, somewhat inclining to Yellow, that sweats out of the Earth, and smells like rotten *Cheese*; whereof having gathered a Quantity at *Puteoli*, together with the other Species of *Alum*, and kept it a while by him, when he came to look on it again, he found it to have lost the Smell, and a great Part of it changed into *Alumen Plumeum*; the saline Part, I suppose, shooting into Threads, and the pure Earth uniting them, as found in the Places wherever generated; whether sweating from the Earth, as *Pliny* and *Matthiolus* would have it, or percolated through *Rocks*, as we find it in *Wales*, the Veins of it there running through a Rock of Stone, in Hardness and Colour not unlike Flint.

And yet seems to be made of such an *Alum*, as that of *John Hefsus* at *Puteoli* was, some of it being straw-coloured, as if it still retained the Yellowness that his liquid *Bitumen* was said to have; which is a Colour not given to it by any Author, most of it being said to be white, or cinerous; some of it red, and some of an Iron-Colour, as *Agricola* tells us; and I have some of the *Cyprian* by me, sent from *Aleppo*, by Dr. *Rob. Huntington*, whereof some is of a light blue, or Pearl-Colour, and some of it has a cast of *Sea-Green*.

But however the whole mineral Substances found at several Places may differ in Colour, yet I do not find but the woolly Part of them all seems to be much the same, viz. of a white Silver-Colour, the Threads very fine and slender, yet very ponderous; the smallest Particles of them thoroughly wet, sinking in Water, as I also found a very slender Thrum of the *incombustible Linuen* given me by Mr. *Baily*, which Mr. *Waite* brought from *India*, would also do; which renders it very probable that it is not a Vegetable, but a Mineral Substance, notwithstanding the Informations of *Conco* and *Keayarear Sukradana*, mentioned in Mr. *Waite's* Letter, I say, render it probable, there being several Woods, such as *Box*, *Red-Wood*, *Persian Wood*, &c. that will sink in Water.

De Region.
Orientalibus.

Marcus Paulus Venetus acquaints us, that it is found in *Tartary* in a certain Mountain in the Province of *Chinchinthalas*, and made into Cloth, as he was informed by one *Curficar*, a *Turk*, who was Superintendant of the Mines in that Country, after this manner: The lanuginous Mineral, or *Amianthus*, being first dried in the Sun, is next pounded in a brass Mortar, and the earthy Part separated from the woolly, which is afterwards washed from all Filth whatever that may stick to it; and so, being thus purged, is spun into Thread like other Wool, and after wove into Cloth; which if foul or spotted, they cleanse, he says, by throwing it into the Fire for an hour's Time, whence it will come forth unhurt, as white as Snow. Which very method (as *Strabo* describes it) seems also to have been used in ordering the *Cretan Amianthus*; only with this Addition, that after it was pounded, and the earthy Part shook from the woolly, he says it was combed, and so does *Agricola*, which argues there was some of a greater Length than any I have yet seen.

Of this Linen, as *Pliny* informs us, Shrouds were antiently used, at the Royal Obsequies, to wrap up the Corps in, so as that the Ashes of their Bodies might be preserved distinct from those of the Wood, which made the Funeral Pile: And the Princes of *Tartary*, as *Keayarear Sukradana* was credibly informed (and I have it well confirm'd from other Hands) do use such at this Day for burning their Dead. It must be acknowledg'd, it does diminish every time it undergoes the Violence of the Fire; yet this hinders not, but it may, and will, do that Service divers times, before it be render'd altogether useless. Some of the Antients are said to have made themselves Cloths of it, particularly the *Brachmans* amongst the *Indians*. The Wicks for the perpetual Lamps of the Antients were also made of this Substance; and we are told, that *Septalla*, Canon of *Milan*, had Thread, Ropes, Net-works, and Paper of it. *Marco Antonio Castagna*, who lately found this Mineral somewhere in *Italy*, knows how to prepare and render it tractable and soft; which he can thicken and make thin to what Degree he pleaseth, and maketh it thereby, like either to a very white Skin, or a very white Paper. We have also made Paper of our *Welsh Amiantus* lately here at *Oxford*, which will both bear Fire and Ink well enough, the Ink only turning red by the Violence of the Fire.

To shew the Reason whence it is that this Substance should be so strangely privileged by nature, we must consider, that the Qualities and Power of the Fire, according to *Aristotle*, are διακρίνειν τὰ μὴ ὁμόφυλα, συνκρίνειν δὲ τὰ ὁμόφυλα, to separate things of a different, and unite those of a like nature. Hence it is, that the Subjects most apt to take Fire, and be dissolved by it, we find to be such heterogeneous Bodies, in whose Pores the most sulphurous bituminous and aqueous Particles are lodged; which being seized by Fire, are quickly put into motion, dilated and separated; and being thus made capable of flying away, are at last consumed, and dissolve the Frame of those Bodies whose Parts before were united by them. When these are fled and gone, the Fire naturally goes out, as having nothing now left to work upon, nothing remaining but the Salts and Earth in the form of Ashes, which in all sorts of Compounds are the things that resist this Element most, and will remain after the most exalted Operation it can be forced to. Nor do the Salts only of mixt Bodies thus baffle the force of Fire; but the simple ones much more, as being more homogeneous, as we see in the Decrepitation of common Salt, and Exiccation of Vitriol, which, when the aqueous Parts are once evaporated, are now a pure simple homogeneous Body, no more sensible of the Fire, the Decrepitation ceasing, and nothing remaining that can be dilated any further to break the Corns of Salt. Now whatever the Fire cannot dilate, it cannot separate, nor consequently destroy, or carry any thing from it, but what is heterogeneous, and accidentally adhering to the outside of it; which is perfectly the Case of our incombustible Linen, whose Threads being altogether homogeneous, and nothing else but the pure *Stria* of liquid Alum, as was shewn above, holding nothing of Sulphur, Bitumen or Water, or any thing that is different or heterogeneous to itself, that can be dilated or separated, it is in no possibility of being liable to the Fire; which may indeed

pass thro it, as we see it does when it is made red hot, but can carry nothing from it, but such accidental Filth as has been put upon it, or accrued by using.

Lapis Calaminaris, By Mr. Giles Pooley, p. 198. p. 672.

XCIV. The *Lapis Calaminaris*, or *Calamine*, which is digged and prepared near *Wrighton* in *Somersetshire*, is found sometimes in Meadows, sometimes in arable, sometimes in pasture, and as I have observed, most commonly in barren and rocky Ground. The Waters thereabouts are much of the same Colour, Taste, Clearness, and Wholesomeness with other Water. The Grass upon the Ground, and the Leaves of the Trees, are as fresh where Calamine lies as in any other Place. But this I observe, that the Groovers always dig for it upon or near Hills; for they expect none in those Grounds which have no Communication with Hills.

To find out a Vein, they dig a Trench till they come to the Rocks, where they expect it lies; which Trench they generally dig from the North to South, or near upon that Point, the Courses usually lying from East to West, or at 6 a Clock, as their Term is; but sometimes the Courses, Seams, or Rakes, as they call them, lie at 9 a Clock, and sometimes are perpendicular, which they call the high time of the Day, or 12 a Clock: and these Courses they esteem the best. These Seams or Courses run between the Rocks generally wider than those of Lead-Ore, unless they are inclos'd in very hard Cliffs, and then they are narrow as the Veins of Lead. The Colour of the Earth where the Calamine lies, is generally yellow a Grit, but sometimes black; for all Countries, as they term their underground Works, are not alike.

The Calamine it self is of several Colours, some white, some reddish, some greyish, some blackish, which is counted the best; and when this is broken it is of several Colours.

In working for it below in the Countries, they use the same way and Instruments, as they do in Lead Mines, and sometimes they light upon a good Quantity of Lead, but always find some Eyes of Lead among the Calamine; tho I think, in Lead-mines, they do not always find Calamine. In landing of the Calamine, some Pieces are bigger than others, and mixt with a gritty Earth. I have been inform'd, that they have found one entire Piece of 8 or 10 Tun, which by reason of its bigness was forc'd to be broken in the Groove before it could be landed. But generally it riseth in small Particles; some about the bigness of a Nut they call a small Calamine. In antient Works, Damps and Stenches sometimes arise, but never in new Works.

When they have landed a good Quantity of the Calamine, they wash, clean, or buddle it as their Term is, which they perform after this manner. They enclose a small piece of Ground with Boards or Turfs, thro which a clear Stream of Water runs; within this Enclosure they shovel and often turn their Calamine, and the impure and earthy Parts the running Water carries away, and leaves the Lead and the Calamine, and the other heavier stony and sparry Parts behind. When they have thus washed the Calamine,

as clean as they can, having rak'd up the bigger Pieces both of the Lead and Calamine, they put the smaller Parts into Sieves, made of strong Wire at the bottom: And these they often dip and shake up and down in a great Tub of Water, whereby the parts of the Lead which are mixt amongst the Calamine sink to the bottom of the Sieves, the Calamine remains in the middle, and the other sparry and thraschy Parts rise up to the top; which they skim off and throw away, then they take off the Calamine, and after that the Lead. When they have thus cleansed the Calamine, they are forc'd to spread it abroad, and so pick out with their Hands the Trash and Stones that remain. But all of it does not require so much Trouble; for some riseth big enough out of the Works to be cleansed and pick'd fit for the calcining Oven without all this Charge and Pains: And I have seen several Loads of this great Calamine, which had no mixture of Earth or Trash in it.

Their Calamine being thus prepared, they carry it to the Oven, which, at least that which I saw, is much bigger than any Baker's Oven, and made much in the same Fashion: Only they cast in their Coals into a Hearth made on one side of the Oven, which is divided from the Oven it self by a Hem or Partition made open at the top, whereby the Flame of the Fire passeth over, and so heats and bakes the Calamine. They let it lie in the Oven for the space of four or five Hours, (the Fire burning all the while) according to the strength of the Calamine, some being much stronger than other, and so requiring longer time; and while it continues in the Oven, they turn it several times with long Iron Coal-rakes; when it is sufficiently burned, baked, and dried, they beat it to a Powder with long Iron Hammers, like Mallets, upon a thick Plank, picking out what Stones they find amongst it; so that at last the Calamine is reduced to Dust, and then it is fit for the Merchant.

I have been credibly informed that the Dust of Calamine conduces much to the curing of sore Eyes of Men: And that it's frequently made use of, for the taking off Films from the Eyes of Horses and other Beasts.

XCV. 1. Take of Antimony one Pound, flux it clear; have one Ounce, or two, of the Cawk-stone (by and by to be described) in a Lump red-hot in readiness. Put it into the Crucible to the Antimony; continue the Flux a few Minutes: Cast it into a clean and not greased Mortar, decanting the melted Liquor from the Cawk.

*To vitrify
Antimony
with Cawk;
By Dr. Mar.
Lifter. n.
110. p. 225!*

This process gives us above 15 Ounces of Vitrum of Antimony, like polish'd Steel, and as bright as the most refin'd Quick-silver. The Cawk seems not to be diminish'd in its Weight, but rather increas'd; nor will it be brought to incorporate with the Antimony, tho flux'd in a strong Blast.

This Cawk-stone is a very odd Mineral, much akin to the white milky mineral Juices of the Lead Mines, which vitrifies in like manner. Besides these I could never light upon any one mineral Substance, which had any such Effect upon Antimony.

*Vid. Sup.
Sect. XLVI.*

Cawk is a ponderous white Stone, found in the Lead Mines ; it will draw a white Line like Chalk or the *Gallactites* ; but it is more fine, and hath a smooth and shining Grain, Sparr like, yet not at all transparent.

The Virtue
of Antimo-
ny ; By---
n. 39. P. 774.

2. I try'd that a Boar, to whom I had given an Ounce of crude Antimony at a time putting him into the Sty, would be fat a Fortnight before another, having no Antimony, upon the like feeding. Antimony will recover a Pig of the Measles ; by which it appears to be a great Purifier of the Blood. I knew a Horse that was very lean and scabbed, and could not be fatted by any keeping, to whom Antimony was given for two Months together every Morning, and that upon the same keeping he became exceeding fat. One of my own Horses having had the Fissions, and being cured, had notwithstanding extream running Legs ; so that after he had passed the Course of Farriers twice, to be cured, it was not done ; but upon my giving him Antimony one Week, he was presently heal'd.

The manner of using it, is this. Take one 3 of crude Antimony powder'd for one Horse, and when you give him his Oats in a Morning, shake it out amongst his Oats : or make it in Balls.

A black shi-
ning Sand
from Virgi-
nia ; Exa-
mined by
Dr. All.
Moulen. n.
197. p. 624.

XCVI. A small Vial fill'd with ordinary white Sand, and containing only 1b i. gr. xi. being fill'd with *Virginia* Sand was found to contain 3 ii. 9 ii. gr. i.

This Sand did apply to the Magnet both before and after Calcination ; but the latter did apply better to it than the former.

A Parcel of this Sand mix'd and calcin'd with powder'd Charcoal, and kept in a melting Furnace for about an Hour, yielded no *Regulus*, but apply'd more vigorously to the Load-stone than either of the former.

I flux'd a Parcel of this Sand with Fix'd-Nitre, in a melting Furnace, for above an Hour, but could obtain no *Regulus*, nor any Substance that would apply to the Magnet, excepting a thin Crust that stuck firmly to a piece of Charcoal that dropt into the Crucible when the Matter was in Fusion.

I flux'd it also with Salt-petre and powder'd Charcoal, dropping pieces of Charcoal afterwards into the Crucible. It continued about an Hour in the melting Furnace in Fusion, and that without producing a *Regulus*, or a Substance that would apply to the Magnet, excepting only what stuck to the Charcoal, as in the former Experiment.

I flux'd another Parcel of it with Salt-petre and Flowers of Brimstone, without being able to procure any *Regulus*.

I pour'd good Spirit of Salt on a Parcel of this Sand, but could observe no *Lustation* thereby produc'd.

I pour'd Spirit of Nitre, both strong and weakned with Water, on Parcels of the same Sand, without being able to discover any Conflict.

I pour'd single *Aqua Fortis* upon another Parcel of it, without being able to perceive any *Ebullition* worth noting.

I pour'd double *Aqua Fortis* upon another Parcel of it, which, for ought I could discover, had no more Effect on it than the former.

I pour'd also some *Aqua-Regia* on a Parcel of it, without discovering any sensible Effect. I pour'd good Oyl of Vitriol upon another Parcel of this Sand, but seeing no Bubbles thereby produc'd, I weaken'd the Oyl with Water, but without any sensible Effect.

I repeated all the former Experiments with the *Menstruums* upon this Sand after Calcination *per se* in a Crucible, but could scarce observe a Bubble produc'd by any of them.

I pour'd some of each of the Liquors upon Parcels of the Powder of this Sand calcin'd, without any Success.

Note, That I made these Experiments both in the Cold, and upon a Sand-Furnace. So that to me there seems to be but little wanting to discover any Metal known to us, if it contained any such: for there is no Metal nor Ore that some of these *Menstruums* will not work on.

I powder'd a Fragment of a Load-stone, and pour'd some of these *Menstruums* upon it, without being able to find that they in the least prey'd upon it, any more than they did upon the Sand.

I pour'd some of the afore-mention'd *Menstruums* upon ordinary Sand taken out of a Sand-Furnace, where it must have suffer'd some Calcination; but could find no more Bubbles produc'd thereby, than what might rationally be suppos'd to be produc'd from Lime, and other Dirt mixt with the Sand.

XCVII. The black Sand, which in *Italy* they use instead of Dust to their Letters, is found six Miles from *Genes* near *St. Pierre d'Araine* on the Sea-shore. It hath the Properties of the Load-stone, and I do believe that it is Load-stone, or Powder of Load-stone, for it followeth the Load-stone; it sticketh to a Knife that is touched with the Load-stone; it draweth a magnetick Needle; it doth not ferment with *Aqua Fortis*, as Iron Dust doth; it doth not rust with any Acid that can be put to it; it doth not sparkle in the Flame of a Candle, as Steel Dust doth, when it is thrown into the Flame. It is commonly found on the Sea-shore after great Storms.

A black Sand from Italy; By Mr. Butterfield, n. 244. p. 336.

XCVIII. A certain Powder lately invented in *Germany* maketh Metal so close and smooth, that it leaves not the least Pit in the Piece: a Gun so cast needs no boaring, and one third of the Metal may be spared. Such Guns remain clean and neat a long while. July 9. 1672. there was cast a Demi-Cannon, weighing 34 Hundred, which was tryed with a Bullet of 34 lb. and the first time 12 lb. of strong Powder, the second time as much, the third time 15 lb. and the fourth time 24 lb. all which it endur'd very well. With a small Petard, of 2 lb. of this Metal, I broke in pieces a Beam of a *Rhine* Foot square, the Petard remaining entire and perfect.

To make Metal run smooth and close; By... at Frankfurt on the Main, n. 94. p. 6040.

This Powder is not only easy to make, but also of small Expence.

XCIX. The

Iron works
in Gloucester-
shire; By
Mr. Hen.
Powle, n.
137 p. 931.

XCIX. 1. The Forest of *Dean* (lying betwixt the *Wye* and *Severn*) consists generally of a stiff Clay. The Country is full of Hills, but they are no where high: Betwixt them run great Store of little Springs of a more brownish Colour than ordinary Waters, and often leave in their Passage Tinctures of Rust. The Ground is naturally inclin'd to Wood, especially Hasle and Oak; but 'tis now almost devoured by the increase of the Iron-works. Upon the Surface of the Earth, in many Places, lie an abundance of rough Stones, some of them of a vast Bulk; but where they sink their Mines, they rather meet with Veins of scaly Stone, than hard and solid Rocks. Within the Forest they find great plenty of Coal and Iron-Ore; and in some Places red and yellow Oker.

The Iron-Ore is found in great abundance in most Parts of the Forest; differing both in Colour, Weight, and Goodness. The best, which they call their Brush-Ore, is of a bluish Colour, very ponderous and full of little shining Specks like Grains of Silver. This affords the greatest quantity of Iron: but being melted alone produceth a Metal very short and brittle. To remedy this Inconveniency, they make use of Cinder, which is found in great Quantities thro all Parts of the Country, where any former Works have stood; for in former Times, their Bellows being mov'd only by the strength of Men, their Fires were much less intense than in the Furnaces they now employ: So that they melted down only the principal Part of the Ore, and rejected the rest as useless. This is call'd Cinder, and being mingled with the Ore in a due Quantity, gives it that excellent Temper of Toughness, for which this Iron is prefer'd before any that is brought from foreign Parts.

The Ore is first calcined in Kilns, much after the Fashion of ordinary Lime Kilns; which they fill up to the top with Coal and Ore, *Stratum super Stratum*: Then putting Fire to the bottom, they let it burn till the Coal be wasted. This is done without Fusion of the Metal; and serves to consume the more drossy parts of the Ore, and to make it friable. From hence they carry it to their Furnaces, which are built of Brick or Stone, about 24 Foot square on the out side, and near 30 Foot in height: Within not above eight or ten Foot over in the middle, the top and bottom having a narrower Compass, much like the shape of an Egg. Behind the Furnace are placed two huge pair of Bellows, whose Noses meet at a little Hole near the bottom. These are compressed together by certain Buttons, placed on the Axis of a very large overshot Wheel.

The Furnaces are at first filled with Ore and Cinder intermixt with Fuel, which in these Works is always of Charcoal; laying them hollow at the bottom, that they may more easily take fire: But after they are once kindled, the Materials run together in a hard Cake or Lump which is sustained by the Fashion of the Furnace, and thro this the Metal, as it melts, trickles down into the Receivers, where there is a Passage open, by which they take away the Scum and Dross. Before this lies a great Bed of Sand, wherein they make Furrows of what Fashion they please; into these they let in their Metal, which is made so very fluid by the Violence of the Fire, that it con-
tinues

tinues boiling for a good while. The Furnaces are kept at work Night and Day for many Months; still supplying the waste of the Fewel, and other Materials, with fresh poured in at the top.

From these Furnaces they bring their Sows and Pigs of Iron (as they call them) to their Forges. These are of two sorts, tho standing together under the same Roof; one they call their Finery, the other the Chafery. Both of them are upon Hearths, on which they place great heaps of Sea-coal, and behind them Bellows like to those of the Furnaces, but nothing near so large. Into their Finery they first put their Pigs of Iron, placing three or four of them together behind the Fire, with a little of one end thrust into it: Where softening, by degrees, they stir and work them with long Bars of Iron, till the Metal runs together into a round Mass or Lump, which they call a Half-bloom. This they take out, and giving it a few Strokes with their Sledges, they carry it to a great weighty Hammer, raised likewise by the motion of a Water-wheel; where, applying it dexterously to the Blows, they presently beat it out into a thick short Square. This they put into the Finery again, and heating it red hot, they work it out under the same Hammer, till it comes to be the shape of a Bar in the middle, with two square Knobs on the Ends. Last of all, they give it other Hearings in the Chafery, and more Workings under the Hammer, till they have brought their Iron into Bars of several Shapes and Sizes. If they omit any one Process, it will be sure to want some part of its Toughness, which they esteem its Perfection.

For the Backs of Chimneys, Hearths of Ovens, or the like, they take the melted Metal out of the Receivers in great Ladles, and pour it into Moulds of fine Sand.

2. 1. At *Milthrop Forge in Lancashire*, they have several sorts of Iron Stone, *In Lancashire; by Mr. John Sturdy. n. 199. p. 695.* some of it making Coldshire Iron, that is, such as is brittle when it is cold; another sort makes Redshire, that is, such as is apt to break, if it be hammer'd when it is of a dark red heat; and therefore they are never melted down but in mixture, and so they yield an indifferent good sort of Iron. They have of late made it much better than heretofore, by melting the Sow-metal over again, as likewise by using Turf and Charcoal; whereas formerly their Fuel was only Charcoal. They first burn the Iron Stone, and then, for every 17 Baskets of this burnt Stone, they put in one of Limestone unburnt, to make it melt freely and cast the Cinder; which they always take off from the melted Iron before they let it run.

The bottom of the Furnace is about two Yards square, and so rises perpendicular for a Yard, or more; which is also lined within with a Wall of the best Fire-stone, to keep off the force of the Fire from the Walls of the Furnace. The Bellows (which are very large, and play'd with Water) enter about the middle of the Focus: The rest of the Furnace is raised upon this, six or seven Yards square-wise, but tapering; so that the top Hole (where they throw in Baskets of Stone and Fuel) is but half a Yard square. When they find it to have subsided about a Yard and an half, then they fill the Furnace again.

The Ore is got in *Furness* (a Division of *Lancashire*) at least 15 Miles from *Milthrop*. Some of it is hard, but feels soft and smooth on the outside, like Velvet. Some is soft as Clay, but all is red; and one sort seems to be good *Hematites*.

1b. p. 697.

2. The Forge is very much like that of a common Black-Smith's, about a Yard and a half over, and the same height. The Hearth is all of Sow-Iron, much of the shape of a broad-brim'd Hat, with the Crown downwards. This hollow Place they fill and heap up with Charcoal, and lay the Ore (first broken into pieces as big as a Pigeon's Egg) all round about the Charcoal upon the flat Hearth, to bake it, as it were, or Neal it, and thrust it in by little and little into the hollow, and keep blowing for some twelve Hours. Then they pull out a Stopple at the bottom of the Wall, and out comes all the Glassy Cinder, being very liquid, leaving the Iron (which is never in a perfect Fusion) in a Lump at the bottom. This they take out with great Tongs, and turn it under heavy Hammers (play'd with Water) which at the same time beat off, or rather squeeze out, the fluid *Scoria* (especially at first taking out of the Furnace) and form it, after several Heats, into Bars. They use no Limestone, or other things, to promote the Flux. They get about an hundred weight of Metal at one melting, which is the product of about three times so much Ore.

1b. p. 699.

Steel is not made from that they call Steel Ore, but Iron, such as is made from the rest.

The several sorts of Ores lie in one Vein, which is sometimes an Inch, sometimes a Foot, and sometimes three or four Yards broad, and many Fathoms deep, between grey Limestone Rocks; but the hard Ores lie usually next the Rocks on each side, and the soft Ore in the midst. They use the soft Ore frequently, and with good Success, as a Medicine for the Murrain in Cattle, and for all Diseases in Swine, to which last they will give a good Handful, or two, in Milk.

By Dr. Lister. ib.

3. This Clay *Hematites* is as good, if not better, than that which is brought from the *East-Indies*; witness the Tea-Pots made of it in *Staffordshire*.

The true Way of making of Steel; By Dr. Mart. Lister. n. 203. p. 865. Vid. inf. Vol. III. par. II. Cap. II. Sect. XLIV.

C. Those famous and stupendous Monuments of Antiquity, the *Egyptian Obelisks*, are all of *Porphyry*, and most of them curiously carv'd with a vast number of Figures, one way of Writing of the antient *Egyptians*: These witness the Facility that Nation had of Graving in *Porphyry*; a Stone which no Tool will now touch, nor nothing less affect, than Emery or Diamond Powder.

Mr. Ray assures us, that all the *Obelisks* of *Rome*, that are graven with *Hieroglyphicks*, are of one and the same kind of Stone, viz. a Marble of a mingled Colour, red and white, very hard, and hath not in so many Ages suffer'd the least by the Weather.

Something there is certainly lost in this Age, as to the manner of Steeling of Tools: And the Processes now used by most Nations are fraudulent, and

a poisoning of Iron by certain mineral Salts, rather than a true making of Steel.

Aristotle tells us, " That wrought Iron it self may be cast so as to be made liquid, and to harden again : And they are wont to make Steel thus ; for the *Scoria* of Iron subsides, and is purged off by the bottom. And when it hath been often defecated and made clean, this is Steel. But this they do not often, because of the much Waste, and for that it loses much weight in Fining. But Iron is so much the more excellent, the less Excrement it hath." This Account is a little confused, and not well understood : It is indeed true, that Iron is still better the more it is purged. It is as true, that even wrought Iron may be melted as often as you please ; and as oft as it is melted and purged, it loseth much of its Weight. But after all, Iron of it self, how oft soever it is purged and refined, will never become Steel ; yet of this so purged, the best Steel doubtless may be made. *Meteor.* 1. 4. c. 6.

The manner of making true Steel, is thus faithfully describ'd by *Agricola*. *De Re Met.* lib. 1. 9. And this way by *Kircher* is said to be now in use in the Island of *Ilva*, a Place famous from all Ages, even from the Times of the *Romans*, for that Metal alone, down to our Days.

" Make choice of Iron which is apt to melt, and yet hard, and which may easily be wrought with the Hammer ; for altho Iron which is made of Vitriolick Ore, may melt, yet it is soft, or fragil, or eager. Let a parcel of such Iron be heated red hot, and let it be cut into small pieces, and then mixt with that sort of Stone which easily melts ; then set in the Smith's Forge, or Hearth, a Crucible, or Dish of Crucible Metal, a Foot and a half broad, and a Foot deep ; fill the Dish with good Charcoal, and compass the Dish about with loose Stones, which may keep in the mixture of Stone and pieces of Iron put thereon.

" As soon as the Coal is thoroughly kindled, and the Dish is red hot, give the blast, and let the Workman put on, by little and little, all the mixture of Iron and Stone he purposes.

" When it is melted, let him thrust into the middle of it three or four, or more pieces of Iron, and boil them therein five or six Hours, with a sharp Fire ; and putting in his Rod, stir often the melted Iron, that the pieces of Iron may imbibe the smaller Particles of the melted Iron, which Particles consume, and thin the more gross Particles of the Iron Pieces ; and are, as it were, a Ferment to them, and make them tender.

" Let the Workman now take one of the Pieces out of the Fire, and put it under the great Hammer, to be drawn out into Bars, and wrought ; and then, hot as it is, forthwith plunge it into cold Water.

" Thus temper'd, let him again work it on the Anvil, and break it ; and looking upon the Fragments, let him consider whether it looks like Iron in any part of it, or be wholly condensed, and turned into Steel.

" Then let the Pieces be all wrought into Bars ; which done, give a fresh Blast to the Mixture, adding a little fresh Matter to it, in the room of that which had been drunk up by the pieces of Iron ; which will refresh and strengthen the Remainder, and make yet purer the pieces of Iron again.

“ put into the Dish : Every one of which let him, as soon as it is red hot,
 “ beat into a Bar, upon the Anvil, and cast it, hot as it is, into cold Wa-
 “ ter. And thus Iron is made into Steel, which is much harder and whiter
 “ than Iron.

Lib. 34. c. 14. Pliny, speaking of Iron, says, *Fornacum maxima differentia est: in iis equi-*
dem Nucleus ferri excoquitur ad indurandum aciem, alioque modo ad densandum
incudes malleorumve rostra. From this Passage it should seem that the An-
 tients had one way to make Steel, and another way to harden or temper
 their Tools, particularly such as Picks and Anvils. And it is plain, that
 the *Nucleus Ferri* (by which must be meant well purged Iron, the same which
Aristotle calls *ἰσχυρόν & σιδῆρον*) was melted down in both. But, in my
 Opinion, with this difference, in making Steel they not only boil'd their
 Iron in its own Sow-Metal, or liquid Iron, but hammer'd it also, and after
 quench'd it in cold Water.

And this Opinion those other Words of Pliny, in the next Chapter, favour,
Ferrum accensum Igni, nisi duretur ictibus, corrumpitur: And again, *Aquarum*
summa differentia est, cui subinde candens immergitur. And this way was suffi-
 cient for Sword-Blades, and Knives, Razors, &c. Whereas in steeling
 their Tools, they boil'd their Tools in Sow-Metal, to such a degree of
 Hardness or Temper as was requisite, and did not afterwards hammer them.
 For Iron this way made into Steel, becomes a kind of *Electrum*, and is fill'd
 with an exceeding brittle and hard Body; for which purpose the Word *Den-*
sare is, by Pliny, aptly and elegantly used. And this way was used when
 the strongest Temper and Hardness was required, as to Picks and Anvils:
 For it is certain that Steel, as well as Iron, by Ignition, is spoil'd or cor-
 rupted. Hence it was that the Antients well knowing, that in making
 their Tools out of Steel, they could not but considerably lose and abate of
 their Temper; they first shaped them, and then gave them a strong Body
 of Steel and Temper together, and so had nothing else to do but to finish
 them on the Grindstone and Hone, to set the Point or Edge.

Copper
 Mines in
 Hungary; By
 Dr. Edward
 Brown, n.
 59. p. 1042.

CI. 1. *Herrn-Ground* is a little Town in *Hungary*, seated very high be-
 tween two Hills, upon a part of Land of the same Name, an *Hungarian*
 Mile distant from *Newsol*. In this Town is the Entrance into a large Cop-
 per Mine, very much digged.

I went in thro a *Cuniculus*, call'd *Tach-stoln*. The steep Descents are
 made by Ladders or Trees set upright, with deep Notches or Stairs cut in
 them to stay the Foot upon. They are not troubled with Water, the Mine
 lying high in the Hill: But they are molested with Dust and Damps.

The Veins of this Mine are large, many of them cumulate, and the Ore
 very rich: in an hundred Pounds of Ore they ordinarily find twenty Pounds
 of Copper; sometimes thirty or forty, half Copper, and even to sixty in
 the Hundred. Much of the Ore is join'd so fast in the Rock, that it is se-
 parated with much difficulty. There are divers sorts of Ore; but the chief
 difference is between the yellow and the black; the yellow is pure Copper
 Ore, the black contains also a proportion of Silver.

They

They find no Quicksilver here ; the Mother of the Ore is yellow, and the Copper Ore heated and cast into Water, maketh it become like that of some sulphureous Baths.

They separate the Metal from the Ore with great difficulty. The Ore commonly passes 14 times thro the Furnace : Sometimes it is burned and other times melted, sometimes by it self, and sometimes mixed with other Minerals and its own Dross.

There are divers sorts of Vitriol found in this Mine, green, blue, red-dish, and white. There is also a green Earth, or sediment of a green Water call'd *Berg grun* ; there are likewise Stones found of a beautiful green and blue Colour, and one sort on which *Turcoises* have been found ; therefore call'd the Mother of the *Turcois*.

There are also two Springs of a vitriolate Water, which are affirm'd to turn Iron into Copper ; they are call'd the *old* and the *new Ziment* ; these Springs lie deep in the Mine : The Iron is ordinarily left in the Water 14 Days ; I took divers Pieces formerly Iron, now appearing to be Copper, out of the *Old Ziment* ; they are hard within the Water, and do not totally lose their Figure, and fall into Powder, they will easily melt without the Addition of any other Substance.

They make handsome Cups and Vessels out of this sort of Copper.

2. There is a heap of Copper Ore by *Darwent* near *Keswick*, but I suppose the Weather hath eaten out all the Copper that was in it : It is reported, that the thickness of the Vein at *Gouldscope* in *Newlands* was six Foot ; there are no Shafts now in being either at *Newlands* or *Caldbeck*, there are divers Adits, but they are useless, the Workmen having wrought down the Ore far below them ; there is part of an Adit wrought at *Caldbeck*, but it is uncertain what it may cost finishing ; for some Stone may be wrought for 20 Shillings a Fathom, and some of it may prove so hard, that it may cost 10 Pound a Fathom.

In Lanca-
shire and
Cumber-
land; By Mr.
Dav. Davies,
to Dr. Lister.
p. 200. p. 737.

A Thousand Pound Stock will be enough to begin with, to get Ore at *Caldbeck* Mines, and then there must be smelting Houses built, which cost 500 Pound or more ; and before Copper be made ready for Sale at the Market, and the Work come to pay it self, it will be six or seven Years at least, and by that time 10000 Pound will be Stock little enough.

3. The first Work that was found, and wrought in by the *Dutch-men*, in *Coniston Fells*, is call'd Low Work, it hath a Stulm or Shaft to draw Water from the Mine. This Work was left good, and had been wrought from the Day to the Evening End of the said Work 40 Fathoms, or thereabouts ; the Seam or Vein of Copper Ore then left was above three quarters of a Yard thick of good Ore ; which Seam or Vein did go from the Evening End to the Morning End of the said Work, and was esteemed 200 Fathoms betwixt, wrought as the Vein went, and was, when left, all near of a breadth or thickness. The Copper Ore in this Work was mixed with some Silver or Lead Ore.

By---to Dr.
Lister. ib. p.
741.

The Second Work is called white Work or new Work, about forty

C c c c 2

Fathom

Fathom from the first, was wrought about 10 Fathom deep ; the Seam then left was about 22 Inches of good Copper Ore.

The third is called *Tung-Brow*, a little distant from the last, being wrought about 30 Fathom, and the Seam about two Foot thick of the like Ore.

The fourth is call'd *God's Blessing*, or *Thurdlehead*, being wrought about 30 Fathom, and being from the last Mine about a Mile, the thickness of the Seam of Ore above a Yard, when left off, and thought to be much of it Gold Ore.

The fifth, call'd *Hen-Cragg*, is a mile from the last, wrought about two Fathoms ; a small Seam, but excellent Ore.

The sixth Work is call'd *Sumy-Work* at *Lewers Water*, at the Water-side, and a little above that, *Hanch Clocker's Work* ; a little above that, *George Towers* and *William Dixson's Work* ; *Bartle Clocker's Work* ; near the last, *Richard Tower's Work* ; then *John Saclock's Work*, and *Hanch Mire's Work* ; being all seven Works, and lie altogether, and about a Mile from the fifth Work above said ; and wrought about 10 or 12 Fathom ; the Seam of Ore about 16 Inches thick ; the Stone very soft, and the Ore very rich, and much of the said Ore green. If the Turn was drain'd, it's thought that all these seven Works would come into one, and that it would be the best Work that ever was in these Parts.

The seventh Work is call'd *Gray-Cragg-Beck*, wrought but a little, the Seam about 18 Inches thick, of as good Ore as any of the other Works.

The eighth is call'd *John Dixson's Work* in *Brumsell*, was wrought about two Fathom, the Seam about 24 Inches thick, and esteem'd the best Ore, except *God's Blessing*. It is about half a Mile from the last Work.

The ninth Work is call'd the *Wide Work*, or *Thomas Hirn's Work*, wrought about 60 Fathom, and left a Seam above 26 Inches thick, when the Work was given over, of very good Ore. It has a Shaft or Pump to draw the Water away, and it is from the last Work about two Miles.

The tenth Work is call'd *Three Kings* in *Tilburthwait*, being three Works, and wrought above 40 Fathoms apiece, the Seam being above 14 Inches of very good Ore.

These are all the Works that have been wrought in *Coniston-Fells* : Most of them have small Seams near the Copper, of a gray sort of Ore in small Thread.

There are lately discover'd three Veins in *Torwerwel*, and about 10 in other Places, and all within two Miles of the first Work in *Coniston-Fells*, and as hopeful as those that have been wrought in.

When the Ore which was got at *Coniston*, came to be smelted at *Keswick*, they found it so much to exceed the Copper Ore of either *Caldbeck* or *Newlands*, that they let fall these Works, and sent the Workmen to *Coniston-Fells* ; so that there were 140 Men kept constantly at the Works there ; and the Ore that they got, did sufficiently furnish and supply the Smelt Houses at *Keswick*.

The Rate that was given for getting of Copper Ore, was according to its Goodness, from eight Shillings a Kibble to two Shillings and six Pence, every Kibble being near a Horse-Load in weight, it being first beaten very small, washed and sifted thro an Iron Sieve, then measur'd or weigh'd.

There was near the first Work a Stamp-House, which went by Water, and several Persons were employ'd to bring the Refuse from each Work, that the Miners did throw away, to the Stamp-House, where it was stamped, washed, and ordered, and they had two Shillings and Six-pence for their Pains.

CII. Calamine is digg'd out of several Mines in the West of *England* (as about *Mendip, &c.*) about 20 Foot deep. It is burn'd or calcin'd in a Kiln or Oven made red hot, then ground to Powder, and sifted into the fineness of Flower, then mix'd with ground Charcoal, because the Calamine is apt to be clammy, to clod, and not so apt or capable of incorporating. Then they put about seven Pound of Calamine into a melting Pot, of about a Gallon content, and about five Pound of Copper uppermost; the Calamine must be mix'd with as many Coals as will fill the Pot. This is let down with Tongs into a Wind Furnace, eight Foot deep, and remains 11 Hours therein; they cast off not above twice in 24 Hours. One Furnace holds eight Pots. After melting, it is cast into Plates or Lumps.

45 Pound of raw Calamine produces 30 Pound burnt or calcin'd.

Brass Shruff serves instead of so much Copper, but this cannot always be procur'd in Quantities, because it is a Collection of Pieces of old Brass, which is usually procur'd in small Parcels.

The best Guns are not made of malleable Metal, and cannot be made of pure Copper or Brass, but it is necessary to put in coarser Metals to make it run closer and sounder, as Lead and Pot-metal; Bell-metal being Copper and Tin; and Pot-metal Copper and Lead. About 20 Pound of Lead is usually put into 100 Pound of Pot-metal; but about six Pound is sufficient to put into 100 Pound of Gun-metal.

The Calamine Stones were heretofore fetch'd from *Poland*, but since fetched from hence by the *Dutch*.

The Manufacture of Brass was privately kept in *Germany* for many hundred Years; wherein many Thousands were employ'd, and all were maintain'd; some having thereby rais'd themselves to great Estates.

CIII. It is suppos'd by the Miners, that there was a great Concussion of the Waters in that Separation of the Waters from the Waters at the Creation, when the dry Land first appear'd, or at *Noah's Flood*, or at both times: Whereby the Waters mov'd and remov'd the (then) Surface of the Earth. That till then the uppermost Surface of mineral Veins, or Loads, did (in most Places) lie even with the (then real, but now imaginary) Surface of the Earth, which is now call'd the *Shelf*, or *Fast Country*, or Ground that was never moved. But at this Concussion of the Waters, the Surface of the Earth, together with the uppermost of those mineral Veins, were loos'd, and torn off; and by the descending of the Waters into the Valleys, both the Earth, or

Grewt,

To make
Brass, by
Mr. Tho. Po-
vey. n. 200.
P. 735. n.
260. P. 474.

The Tin
Mines in
Devonshire,
and Corn-
wal, by --
n. 69. P.
2096.

Grewt, and those Mineral Stones or Fragments so torn off from their Loads (which are constantly term'd *Shoad*) were together with, and by the Force of the Waters carried beneath their proper Places, and from some Hills, even to the bottoms of the neighbouring Valleys; and from thence by Land-Floods many Miles down the Rivers.

Trayning a
Load.

1st. Upon these Suppositions, we proceed in trayning a Load, thus;

1. Where we suspect any Mine to be, we diligently search that Hill and Country, that we may the better know the *Grewt* and Stones, when we meet with them at Distance in the neighbouring Vally.

2. Then we observe the Frets in the Banks of Rivers that are newly made by any great Land-Flood, which usually are then very clean, to see, if happily we can discover any metalline Stones in the sides and bottoms thereof, together with the Cast of the Country, (*i. e.* any Earth of a different Colour from the rest of the Bank) which is a great help to direct us, which Side or Hill to search into. The mineral Stones are discover'd either by their Ponderousness, or by their Porosity, for most Tin Stones are porous, not unlike great Bones, almost thoroughly calcin'd; yet Tin sometimes lies in the firmest Stones: or by Vauning, which is perform'd by pulverizing the Stone or Clay, or what else may be suspected to contain any mineral Body, and placing it on a Vauning-shovel; the Gravel remains in the hinder Part, and the Metal at the Point of the Shovel, whereby the Kind, Nature, and Quantity of the Ore is very nearly guess'd at.

3. If no *Shoad* be found in these Frets, we trust not to any found in the River, it being uncertain from whence the Water may have brought them. But we go to the side of those Hills most suspected, where there may be a conveniency of bringing a little Stream of Water, the more the better, and cut a Leat, Gurt, or Trench, about two Foot over, and as deep as the Shelf, in which we turn the Water to run two or three Days; by which time the Water, by washing away the Filth from the Stones, and the looser parts of the Earth, will easily discover what *Shoad* is there. If we find any, we have a Certainty of a Load in the upper Part of the Hill, or at least a Squat.

4. Sometimes *Shoad* may be found upon the open Surface of the Ground, but then 't's brought thither by some Accident; for the Corruption of Vegetables and other Creatures, have in a long Tract of Time since the Deluge, begotten a new Surface, heighten'd in some Places a Foot or more above the Shelf: and this is demonstrable to the Eye in every Tin Work.

5. At the Foot or Bottom of the Hill, we sink an Essay Hatch, or a Hole about six Foot long, and four Foot broad, and always as deep as the Shelf. If we find no *Shoad* before, or when we come to the Shelf, there is none to be expected: Yet sometimes the *Shoad* is wash'd away clean, when you come within two or three Foot from the Load, which then lies so much farther up in the Hill. If we find *Shoad*, we are almost at a certainty: And this is held as an infallible Rule, that the nigher the *Shoad* lies to the Shelf, the nigher the Load is at hand, & *vice versa*.

6. If we find no *Shoad* in this first Hatch, we ascend commonly about 12 Fathom, and sink a second Hatch, as the former. And in case none appear in this,

this, we go then as many Fathom on each hand at the same height, and sink there as before ; and so ascend proportionably with three or more Hatches, if the space of Ground requires, as it were in Breast, till we come to the Top of the Hill : and if we find none in any of these Hatches, then farewell to that Hill.

7. But if we find any Shoad in any of these Hatches, we keep our ascending Hatches in a direct Line ; and as we draw nearer the Load, we lessen our first Proportion of 18 Fathom, to six or less, as our Conjecture guides us.

8. If finding Shoad lying near the Shelf in one Hatch, and none in the next ascending, we conclude that we have certainly over-shot the Load ; and then we sink nigher that Hatch, wherein we last found Shoad.

9. Sometimes we find two different Shoads in the same Hatch at different Depths, and then we have a certainty of another Load above the former ; and it may be in training up to the second, we meet with the Shoad of a third. Some Tinnners affirm, that seven Load may lie parallel to each other in the same Hill, but yet one only Master Load ; the other six, three on each side, being the lesser Concomitants. So may five lie in like manner ; three are common.

10. Every Load has, as it were, a peculiar coloured Earth or Grewt about it, which is found likewise with the Shoad in a greater quantity, the nearer the Shoad lies to the Load, and so lessen'd by degrees to about a quarter of a Mile's Distance ; farther than which, that peculiar Grewt is never found with the Shoad.

11. A Valley may so lie, as at the Feet of three several Hills : and then we may find three several Deads, *i. e.* common Earth, or that loose Earth which was mov'd with the Shoad in the Concussion, but not contiguous to the Load in its first Position, which is also term'd by us the Run of the Country, with as many different Shoads in the midst of each. And here the Knowledge of the Cast of the Country, or each Hill, in respect of its Grewt, will be very necessary, for the surer training of them one after another, as they lie in order, according to the foregoing Rules of Essay Hatches ; for the uppermost will direct you, with which Hill to begin first,

12. It may be, that after we have train'd up the Hill, instead of a Load, we find nought but a Bonny or Squat, which likewise have their Shoad, whose Form is about two or three Fathom long, and half as broad ; few larger, most less, which communicates with no other Load or Vein, neither doth it send forth any of its own, but is entire of it self, and may go down into the Shelf five or six Fathom deep, and there terminate.

2dly. When we have found the Load, the last Essay Hatch is then called a Tin Shaft, or Tin Hatch, which we sink down about a Fathom, and then leave a little long square Place, term'd a Shamble, and so continue sinking from Cast to Cast, *i. e.* as high as a Man can conveniently throw up the Ore with a Shovel, till we find either the Load to grow small, or degenerate into some sort of Weed, which are divers ; as *Mundick*, or *Maxy* corrupted from *Marchasite*, white, yellow, and green ; *Daze*, which is a kind of glittering Stone

Digging the
Ore. ib. p.
2101.

Stone enduring the Fire, of different Colours, white, black, and yellow; *Iron-mould*, black, and rusty; *Caul*, red, (differing both from *Mundick* and *Sparr*, enduring the Fire) which *Marcasite* will not; *Glisten*, blood-red and black.

2. We then begin to make a Drift three Foot wide, and seven high: And if the Load be not broad enough of it self, as some are scarce half a Foot, then we usually break down the Deads, or that part of the Shelf which contains no Metal, but encloseth the Load, as a Wall, between two Rocks; and then we begin to rip the Load it self.

3. The Instruments we make use of, are, 1. A Beele, or *Cornish* Tubber, i. e. double Points, of eight Pound or 10 Pound weight, sharpened at both Ends, well steel'd and holed in the middle; it may last in a hard Country half a Year, but new pointed every Fortnight at least. 2. A Sledge, flat headed, from 10 Pound to 20 Pound weight, 'twill last about seven Years, new order'd once a Quarter. 3. Gadds or Wedges of two Pound weight, four square, well steel'd at the Point; they will last a Week; two or three Days, then sharpened. 4. Ladders. 5. Wheel-Barrows, to carry the Deads and Ore out of the Drifts or Adits, to the Shambles.

4. There are two Shovel-men and three Beele-men, which are as many as one Drift can contain, without being an Hindrance to each other. The Beele-men rip the Deads and Ore, the Shovel-men carry it off, and land it, by casting it up with Shovels from one Shamble to another, unless it be where we have a Winder with two Keebles, or Buckets, one of which comes up as the other goes down.

5. It is generally observed, that most of our Tin Loads run from West to East, and then they constantly dip towards the North; sometimes they underlie, that is, slope down towards the North, three Foot in eight perpendicular: Yet in the higher Mountains of *Dartmoor* there are some considerable Loads, which run North and South, these underlie towards the East.

6. Four or five Loads may run parallel to each other in the same Hill, and yet, which is rare, meet altogether in one Hatch, as it were in a Knot, which well tins the Place, and so separate again, and keep their former Distances: Such a Knot hath been observed and wrought on *Hingston*, a known mineral Down or Common in *Cornwall*.

7. The Breadth of Master Loads may generally be from three to seven Foot, seldom larger, unless where several Loads may chance to make a Knot, or send forth Strings or Veins. Neither retain they their usual Breadth in all parts; for they may be six Foot at one place, and not two at another, nay, sometimes scarce half an Inch over; but that is to be understood of Strings, and the narrowest Places of the concomitant Loads.

8. The Load is usually in a hard rocky Country, made up of Metal, Spars, and other Weeds, as it were all along a continued Rock: But it hath many Veins and Joints, as we speak; but in some softer Countries, the Tin may lie in a softer Consistence, as that of Clay in a manner petrefy'd.

9. In most Places we meet with Water at some Feet deep from the loady Surface, in other some not at many Fathoms deep. It runs continually thro the

the Heart of the Load. When it begins to trouble us, we begin at the Foot of the Hill a Drift, or Adit, scarce half so big as that of the Load, and work it on a Level, till we come up to the Load. But if we have not this Conveniency of an Adit, or if we pass that Level, we are forced to draw it with Winders and Keebles, or with Pumps. Some, but very few, Works may be dry.

10. We observe that if we have Water, we never want Air sufficient for Respiration, and our Candles to burn in; yet sometimes, in a soft clayie Country, our Air is so much condensed, that it becomes in a manner a Damp, and requires an Air sharp for vent; which Damps are sometimes enlarged by working of the *Mundick* with the Ore.

11. If the Country be not strong enough, we underprop our Drifts with Stemples and Wall-plates, placed much like a Carpenter's Square, on the one side, and over head.

12. To know which way the Load inclines, or to bring an Adit, or to sink an Air-shaft to the desired Place, the use of the Dial is needful, which we term Plumming and Dialling, and is thus performed. A skilful Person first fastens the end of a long Line at a known Place, and then exactly observes the Point at which the Needle of his Dial, or Compass, rests; and at the next Flexure he makes a Mark on the Line, and again notes the Point at which the Needle stands at this second Station; and so proceeds from Turning to Turning, still marking the Points, and his Line, till he comes to the intended Place. He then repeats above-ground what he had done below, and his Dial and Line lead him, till he comes exactly over the Place where he ended in the Mine.

3. When the Ore is landed, and the greater Stones broken at the top of the Mint by the Shovel-men, 'tis brought on Horses to the Stamping or Knocking Mills, and unloaded at the head of the Pass (*i. e.* 2 or 3 bottom Boards with 2 side Boards sloping-wise) in which the Ore slides down into the Coffer: But that it may not tumble down all at once, there is placed a Hatch nigh the lower end of the Pass (*i. e.* a thwart Board to keep up the Ore) beneath that comes in the Cock-water in a Trough cut in a long Pole, which with the Ore, falls down into the Coffer, *i. e.* a long square Box of the firmest Timber, 3 Foot long, and $1\frac{1}{2}$ Foot over, wherein the 3 usual Lifters, plac'd between 2 strong broad Lones, having 2 Braces, or thwart pieces, on each side to keep them steady as a Frame, with Stamper-heads weighing about 30 or 40 Pound apiece, of Iron, which serve to break the Ore in the said Coffer. These Lifters about 8 Foot long, and $\frac{1}{2}$ a Foot square, of Heart-Oak, and having as many In-timbers, or Guiders, between them, are lifted up in order by double the number of Tappels, fasten'd to as many Arms passing diametrically thro a great Beam, turn'd by an over-shot Water-wheel, on two Boulders, which exactly, but easily, meet with the Tongues so plac'd in the Lifters, as that they quickly slide from each other, suffering the Lifters to fall with great force on the Ore, thereby breaking it into small Sand, which is washed out by the Cock-water, thro a Brass Grate, holed very thick, and placed within two Iron Bars at one End of the Coffer into the Launder, *i. e.* a Trench,

Dressing of
the Tin.

Trench cut out in the Floor, eight Foot long and ten Foot over, stop'd at the other end with a Turf, so that the Water runs away, and the Ore sinks to the bottom; which when full, is taken up and emptied with a Shovel.

2. The *Stamping-Mill* is thus contriv'd to go two Hours, or more, after we give over our Attendance on it. We have a Tiller, *i. e.* a long Pole fastned without at one end to the *Slew*, or *Ponder*, *i. e.* that loose and last part of the Trough that conveys the Stream to the Mill-wheel: and at the lower end is tied a short Rope, with a transverse Stick at the end of it, curiously, but trap-ways hitcht at both ends under two little Pins, fastned in the *Lones* for that purpose. There's another Pin set in one of the *Lifters*, at such an exact height, as that if there be no Ore in the Coffe to keep that *Lifter* high enough, the purposed Pin, in descending, knocks out the Water, carrying it quite over the Mill-wheel; so that when the Coffe is emptied, the Mill rests of its own accord.

3. The *Launder* is divided into three parts, *i. e.* the *Forehead*, the *Middle*, and the *Tail*. That Ore which lies in the *Forehead*, *i. e.* within $1\frac{1}{2}$ Foot of the Grate, is the best Tin, and is taken up in a Heap apart. The *Middle* and *Tails* in another, accounted the worst.

4. The latter Heap is thrown out by the *Trambling Buddle*, *i. e.* a long square Tye of Boards, or Slate, about four Foot deep, six long, and three over; wherein stands a Man bare-footed, with a *Trambling-Shovel* in his Hand to cast up the Ore, about an Inch thick, on a long square Board just before him, as high as his Middle, which is termed the *Buddle-head*; who dexterously, with the one Edge of his Shovel, cuts and divides it long-ways, in respect of himself, about half an Inch asunder; in which little Cuts the Water coming gently from the Edge of an upper plain Board, carries away the Filth and lighter part of the prepared Ore first, and then the Tin immediately after; all falling down into the Buddle, where, with his bare Foot, he strokes and smooths it transversly, to make the Surface the plainer, that the Water and other heterogeneous Matter may, without Let, pass away the quicker.

5. When this Buddle grows full we take it up, here distinguishing again the *Forehead* from the *Middle* and *Tails*, which are trambled over again: But the *Forehead* of this, with the *Forehead* of the *Launder*, are trambled in a second Buddle, but not different from the first, in like manner. The *Forehead* of this being likewise separated from the two other parts, is carried to a third, both *Drawing Buddle*, whose difference from the rest is only this, that it hath no Tye, but only a plain sloaping Board, whereon 'tis once more washed with the *Trambling Shovel*, and so it new names the Ore, *Black-Tin*, *i. e.* such as is compleatly ready for the *Blowing-House*.

6. We have another more curious way term'd *Sizing*, that is, instead of a *drawing Buddle*, we have an hair Sieve, thro which we sift, casting back the Remainder in the Sieve into the *Tails*, and then new tramble that Ore. After the second *Trambling*, we take that *Forehead* in the second Buddle, and dilve it, *i. e.* putting it into a Canvas Sieve, in a large Tub of Water lustily shake it, so that the Filth gets over the Rim of the Sieve, leaving the
black

black Tin behind, which is put into Hogsheads, cover'd and lock'd, till the next Blowing.

7. The Tails of both *Buddles*, after two or three Tramlings, are cast out into the first *Strake*, or *Tye*, which is a Pit purposely made to receive them, and what over-small Tin else may wash away in trampling. There are commonly three or four of them successively, which contain two sorts of Tin; the one which is too small, the other too great. The latter is new ground in a *Craze Mill*, in all respects like a *Greist Mill*, with two Stones, the upper and the nether, and after that trampled in Order; the former, by reason of its exceeding smallness, is dress'd on a *Reck*, provided for that purpose, that is a Frame made of Boards about three Foot and a half broad, and six long, which turns upon two iron Pegs fastened in both Ends, and the whole plac'd on two Posts, so that it hangs in an *Æquilibrium*, and may, like a Cradle, be easily remov'd either way, with the Shovel and Water.

4. When we perceive much *Mundick* in our Tin, which makes it britly hard, Blowing of
Tin. we are necessitated to burn away the Weed in a *Tin Kiln*; this Kiln is four square, and at the top a large Moor Stone, about six Foot long, and four broad; in the middle thereof is an Hole made about half a Foot Diameter. About a Foot beneath this Stone, is plac'd another not so long by half a Foot, because it must not reach the innermost or back part of the Wall, which is the open Place thro which the Flame ascends from a lesser Place below that where a very strong Fire of Furze is constantly made. The fore part is like a common Oven; but near the back on the one side, there is another little square Hole. When the Kiln is thoroughly heated, the black Tin that is to be burnt, is laid on the top Stone, and as much of it is cast down at the square Hole upon the 2^d. or bottom Stone, as will cover it all over about 3 or 4 Inches thick; then the Hole at the top is immediately cover'd with green Turfs, that the Flame may reverberate the stronger: And a Rake-man with an iron Coal-rake, constantly spreads and moves the Tin, that all parts of the *Mundick* may get uppermost of the Tin, and so be burn'd away; which we certainly know by this, that then the Flame will become yellow, (as usual) and the Stench lessen'd; for whilst the *Mundick* behind burns, the Flame is exceeding blue; then with the Rake he thrusts it down, at the open Place into the open Fire, and receives a new Supply of Tin from above. Now when the Place beneath, where the Fire is made, grows full of Tin, Coals and Ashes, with his Rake he draws it forth with the Coals, at the little square Hole on one side, near the Back, where the Ore (fiery hot and red) lies in the open Air to cool, which will scarce be in three Days, because of the Coals that lie hid in it: But in case we cannot stay so long, then we quench it with Water, and it is like Mortar. Albeit we let it cool of it self, or with Water, we must new trample it, or wash it, as before, before we put it into the Furnace, which is no other than an *Alman Furnace*. *Moor-Tin*, i.e. such as is digged up in the Moors, we find runs or melts best with *Moor-Coal*, *chark'd*: But our Tin which lies in the Country, runs best with an equal Proportion of Charcoal and Peate, i.e. Moor-coals, for the first Running; but when we come to remelt our Slags, then we use Charcoal. When all is melted

red down and remelted, there sometimes remains a different Slag in the Bottom of the Float, which we term *Mount Egg*, and that is most an iron Body, tho of a Tin Colour; as I accidentally assur'd my self, by applying one of the Poles of a Loadstone to it, and quickly attracted it, yet not such a Quantity, by far, as that of Iron.

By Dr. Chr.
Merret, n.
138. p. 949.

2. The Stones from which Tin is wrought, are most usually found betwixt two Walls of Rocks, which are commonly of an Iron Colour, of little or no Affinity with the Tin, in a Vein or Lead (as the Miners call it) betwixt 4 and 18 Inches broad, or thereabout. Sometimes there is a rich and fat Metal, sometimes hungry and starv'd; sometimes nothing but a drossy Substance, not purely Earth, nor Stone, nor Metal; but a little resembling the rejected Cinders of a Smith's Forge, appearing sometimes of a more flourishing Colour tending to Carnation, and sometimes more umbratile; and where this is found, the Miners judge the Metal to be ripe. The Pits are sometimes above 60 Fathoms deep.

The Load being very rich and good, above that is 10 Fathoms from the Grafs or thereabouts. And below that, there's a strange Cavity, or empty Place, wherein is nothing but Air for many Fathoms deep, as the Miners have tried with long Poles and Pikes. This Cavity lies between hard stony Walls, distant one from another about 6 or 9 Inches. The Labourers tell Stories of Sprights of small People, as they call them; and that when the Damp ariseth from the subterranean Vaults, they hear strange Noises, horrid Knockings, and fearful Hammerings. These Damps render many lame, and kill others outright, without any visible Hurt upon them.

Tho Tin, for the most part, be made from the Stones in which it is incorporated, yet sometimes it is, as it were, mix'd with a small gravelly Earth, sometimes white, but for the most part red. From this Earth it is easily separated with bare Washing: This gravelly Tin is call'd *Pryan Tin*; and is scarce of half the Goodness of the other.

The *Mundick Ore* is easily discover'd by its glittering, yet sad brownness wherewith it will soon colour your Fingers. This is said to nourish the Tin, and yet they say, where much *Mundick* is found, there's little or no Tin. Certain it is, if there be any *Mundick* left in melting the Tin, it makes it thick and cruddy, that is not so ductile as otherwise; and therefore usually draws down the Metal to an Abatement, from 5 Shillings to 8 Shillings in the Hundred weight. This *Mundick* seems to be a kind of Sulphur. Fire only separates it from the Tin, and evaporates it into Smoak. Little Sprigs or Boughs being set in the Chimney, the Smoak gathers upon them, into a Substance which they call Poyson, and think it a kind of Arsenick, which being put into Water, easily dissolves and produces very good Vitriol. The Water wherein it is dissolv'd, soon changeth small Iron Rods put into it; and they say, that in a very little time it will assimilate the Rods into its own Nature. 'Tis generally concluded, that Fish will die in those Waters whereinto *Mundick* is cast, and they commonly impute the Death of some of their Neighbours to their drinking of *Mundick Waters*. When they burn it, to
separate

separate it from Tin, there proceeds from it a Stench very loathsome and dangerous.

There also occurs a sort of Spar, of a shiny whitish Substance, which casteth a white Froth upon the Water in washing it. When first taken out of the Earth 'tis soft and fattish; but soon after it grows somewhat hard. It is seldom found growing, but only sticking to the Metal. The Miners call it *White Spar*; and some of 'em think it is the Mother or Nourisher of the Metal. But 'tis certain that Spar is often met with in moorish Grounds, where they never hope to find any Ore: Yet no Tin Mines are without it.

The *Cornish* Diamonds, so call'd, lie intermix'd with the Ore, and sometimes on Heaps. They are hard enough to cut Glafs, and some of them are of a transparent red, and have the Lustre of a deep Ruby. These Diamonds seem to me to be but a finer, purer, and harder sort of Spar.

Godolphin Ball is the most famous of all the Balls or Mines in *Cornwal*, for the Quantity of Metal. Tho some of late Years pretend another Mine (which some call the Silver Mine, others the Lead Mine) more rich than that. I have seen an Essay made of some of that Ore, as 'twas said, brought from thence; whereof 10 Pound weight yielded $2\frac{1}{4}$ Ounces of fine Silver.

The best Ore is that which is in Sparks; and next to this, that which hath bright Spar in it.

When the Ore has passed the Stamping-mill, and is well washed and separated from the parts not Metalline (which they call the Causalty) they dry it in a Furnace on Iron Plates, and then grind it very fine in a Crazing-mill. After this they rewash it, then dry it a little, and carry it last of all thus fitted to the Furnace, call'd by them a Blowing-House, and there melt and cast it.

There swims on the Metal, when it runs out of the Furnace, a Scum which they call Dross; much like to Slag or Dross of Iron; which being melted down with fresh Ore, runneth into Metal.

The Causalty they throw in Heaps upon Banks, which in six or seven Years they fetch over again: But they observe that in less time it will nor afford Metal worth the Pains; and at the present none at all.

CIV. 1. I am well inform'd, that all *Mendip* in *Somersetshire* is mountainous: Yet the Hills not equal in height. It is barren and cold, and rocky in some Places. The Ridges thereof run confusedly, but most East and West, and not in any parallel one with another. Upon the Surface thereof, it is heathy, ferny and furzy; and the Cattle it feeds, for the most part, are Sheep, which go there all the Year; and young Beasts, Horses and Colts, at Spring and Fall. The Sheep are not fair, but big-bellied, and will grow to no bigness, after they have been there fed; but will grow fat, if they are remov'd into better Soil; and so their Beasts and Horses.

The Inhabitants live wealthy, saving such as are employ'd about melting of the Lead at the Mines; who, if they work in the Smoak, are subject to a Disease, that will kill them, and the Cattle likewise that feed thereabout. The Smoak that rests upon the Ground will bane them: And therefore

Lead-Mines
in Somerset-
shire; By Mr.
Jos. Glanvil.
n. 28. p. 525.

fore the Inhabitants have Keepers to keep them from it, for fear of the Infection. At the Foot of the Hills there are many Springs which are very wholesome; and produce Rivers, after they have run to some distance from thence. The Air is moist, cold, foggy, thick and heavy.

The Soil is red and stony; and the Stones are either of the Nature of Fire-stones or Lime-stones, but no way clayie, marly, or chalky. The Trees have their Tops burnt, and their Leaves and out-sides discolour'd, and scorched with the Wind, and grow to no Bigness. The Stones that are wash'd by the Brooks and Springs, are of a reddish Colour, and ponderous. Snow, Frost, and Dew, stay upon *Mendip* longer, than upon any of the neighbouring Grounds. Thunder and Lightning, Storms, Nocturnal Lights, and Fiery Meteors, are more frequent than ordinary.

When they have got the Ore they beat it small, then wash it clean in a running Stream; then sift it in Iron Rudders; then they make of Clay, or Fire-stone, an Hearth, or Furnace which they set in the Ground, and upon it build their Fire, which is lighted with Charcoal, and continu'd with young Oak-*Gadds*, blown with Bellows by Men's treading on them: And after the Fire is lighted, and the Fire Place hot, they throw their Lead Ore upon the Wood, which melts down into the Furnace; and then with an Iron-Ladle they take it out, and upon Sand cast it into what Form they please.

A further
account by
Mr. Glanvil.
n. 39. p. 767.

2. I am farther informed, by experienced Mine-Men, that they have sometimes known the Vein to run up into the Roots of Trees, and yet they have observ'd no difference at the Top, with respect to the other Trees there, into whose Roots no such Veins run. The Snow and Frost near the Grooves melt quickly, but continue long at further distance. Sometimes when a Mine hath been very near the Surface, the Grass hath been yellow and discolour'd. They have no value for the *Virgula Divinatoria*; yet they say when the Mine is open, they may guess by it how far the Vein leads. White, yellow, and mixt Earth are Leaders to the Country (as they call it:) Changeable Colours always encourage their Hopes. For Stones, they are sometimes 12 Fathom deep, before they meet any: Other while, when a Stony-Reak at top, they meet Ore just under the Swerd [Superficies] of the Grass, which Ore hath gone down about 40 Fathom. A black Stone is of bad Signification, and leads to a *Jam* [a black thick Stone, that hinders their Work:] A grey clear dry one they account best. They seldom encounter Damps. If in sinking they come to wet moorish Earth, they expect a *Jam*, and to be closed up with Rocks. The nearness they guess by short brittle Clay; for the tough is not leading.

The Ore sometimes is Shole, and again it is 14 or 20 Fathom, more or less before they hit it. They follow a Vein inclining to some depth, when it runs away in flat Binns.

When the Stones part it, then they find a Vein again. Their Draughts are 14 or 16 Fathom, till they come to a Stone, where they cast aside a Draught call'd a Cut: Then they sink plum again four or five Cuts, one under another. They find Ore at 50 Fathom. Their best Reaks are North and South;

South; East and West are good, tho not so deep. The Groove is four Foot long, $2\frac{1}{2}$ Foot broad, till they meet a Stone, when they carry it as they can. The Groove is supported by Timber: A piece of an Arm's bigness will support 10 Tun of Earth. It lasts long; that which was put in beyond the Memory of Man (nay which by the difference in the manner of working their Mines, they know to have lain above 200 Years) will serve in new Works. It is tough and black, and being expos'd to the Sun and Wind for two or three Days, will scarce yield to an Ax.

For the supply of Air they have Boxes of Elm exactly clos'd, of about six Inches in the cleer, by which they carry it down above 20 Fathom. But when they come at Ore and need an *Air-shaft*, they sink it four or five Fathom distant, of the same Fashion with a Groove, to draw as well Ore, as Air.

They make use of Leathern Bags, of eight or nine Gallons apiece, drawn up by Ropes, to free the Water. If they find a *Swallet*, they drive an Adit, upon a Level, till 'tis dry.

If they cannot cut the Rock, they use Fire to aneale it, laying on Wood and Coal, and the Fire so contriv'd, that they leave the Mine before Operation begins, and find it dangerous to enter again, before it be quite clear'd of the Smoak; which hath kill'd some.

Their Beetles, Axes, Wedges, &c. unless so hardned as to make a deep Impression upon the Head of an Anvil, are not fit for their use; and yet they sometimes break them in an Hour; others last three or four Days, as it happens. They work clothed in Frocks and Waist-Coats, by Candle-Light of Tallow, 14 or 15 to the Pound, each whereof lasts three Hours, if they have Air enough; which if they want to keep in the Candles, the Workmen cannot stay there. A Vein being lost, they drive two or three Fathoms in the Breast, as the nature of the Earth directs them. They convey out their Materials in Elm-Buckets drawn by Ropes: The Buckets hold about a Gallon. Their Ladders are of Ropes.

The Ore runs sometimes in a Vein, sometimes dispersed in Banks. It lies many times between Rocks: Some of it is hard, some milder. Many times they have branched Ore in the Spar. About the Ore there is Spar and Chalk, and another substance, which they call the *Crootes*, which is a mealy white Stone, marted with Ore, and soft. The Spar is white, transparent, and brittle like Glafs. The Chalk white and heavy; heavier than any Stone. The Vein lies between the *Coats*, and is of different Breadths. It breaks off sometimes abruptly in an Earth, they call a *Deading Bed*, and after a Fathom or two may come again, keeping the same Point. It terminates sometimes in a dead Earth, clayie, without Croot or Spar; sometimes in a Rock call'd a *Fore-stone*.

The clearest and heaviest Ore is the best; 36 hundred of Ore may yield a Tun of Lead.

The Hearth for melting the Ore is about 5 Foot high, set upon Timber, to be turned as a Wind-mill, to avoid the Inconveniencies of Smoak upon a shifting Wind. It contains half a Bushel of Ore and Coal. There is a
sink

sink upon the sides of the Hearth, into which the Lead runs, that holds about $1\frac{1}{2}$ Hundred. They have a Bar to stir the Fire ; a Shovel to throw it up ; and a Ladle heated red hot to cast out the melted Metal. Once melting is enough ; and the best (which is distinguish'd by its Weight) melts first.

There is a Flight in the Smoak, which falling upon the Grasse, poysons those Cattle that eat of it. They find the Taste of it upon their Lips to be sweet. And when the Smoak chances to fly in their Faces, brought home and laid in their Houses, it kills Rats and Mice. If this Flight mix with the Water, in which the Ore is wash'd, and be carried away into a Stream, it hath poyson'd such Cattle as have drunk of it after a Current of three Miles. What of this Flight falls upon the Sand, they gather up to melt upon a Flag Hearth, and make Shot and sheet Lead of it.

They sometimes find Slags, three, four, or five Foot under Ground ; but such as they judge were cast aside heretofore.

They have sometimes heard Knockings beyond their own Works, which when follow'd by them, have afforded Plenty of Ore. And one *King of Wells* about two Years since found in his Groove a Piece of Ore, in which they fancied the shape of a Man, Eyes, Arms, Legs, full Breast, &c. The whole was about four Inches in length ; the Mine prov'd rich.

*In Germany ;
By ----
n. 1. p. 10.*

3. There is a peculiar Lead Ore found in the *Upper Palatinate*, at a place call'd *Freyung* ; and there are two sorts of it, whereof one is a kind Crystalline Stone, and almost all good Lead ; the other not so rich, and more Farinaceous. The Mines of that Place having lain long neglected, the People living thereabout take it for what their Fathers had thrown away, and had lain long in the open Air. It is of singular use for Essays upon the Coppel, seeing that there is not any other Metal mix'd with it.

*The poyson-
ous Quality
of Lead Ore ;
By Mr. J.
Beaumont.
Ph. Col. n. 2.
p. 6.*

CV. Those who live near where Lead Ore is wash't, cannot keep either Dog or Cat, or any sort of Fowl, but they all die in a short time ; and I have known of a little House wherein Lead Ore was kept some time, tho afterward made very clean and well bedded with Fern, yet when Calves were put into it, they all died shortly after ; and Children sometimes, in these Houses, have died suddenly. If any sort of Cattle eat often of that Grasse, on which the Steam, which rises from the Smelting of Lead, falls, they all die in a while after.

*The Way of
making of
Cerufs ; By
Sir Philiber-
to Vernati.
n. 137. p.
935.*

CVI. Pigs of clean and soft Lead are cast into thin Plates, a Yard long, and six Inches broad. These are roll'd round, so as the Surfaces no where meet to touch : For where they do, no *Cerufs* grows. Each of these is put into a Pot, just capable to hold one, upheld by a little Bar from the bottom, that it come not to touch the Vinegar, which is put into each Pot, to effect the Conversion. Twenty of these abreast, are put into a square Bed of new Horse-Dung ; and each Pot is cover'd with a Plate of Lead ; and lastly, all with Boards, as close as conveniently can be. This repeated four times makes one Heap, so call'd, containing 1600 Pots.

After

After 3 Weeks the Pots are taken up, the Plates unrolled, laid upon a Board, and beaten with Battledores till all the Flakes come off; which, if good, prove thick, hard and weighty. These Flakes are ground with Water, between Mill-stones, to almost an impalpable Fineness. After which it is moulded into smaller Parcels, and exposed to the Sun to dry, till it be hard, and so fit for use.

'Tis observed, that some Pots will yield thick and good Flakes, whilst others, alike ordered and set by them without any possible distinction of Advantage, yield few and small, or none at all. Sometimes the Poles are taken up all dry, and so sometimes prove best; sometimes again they are taken up wet. The Plates that cover the Pots yield better and thicker Flakes, than do the Rolls within. And the outsides, next to the Planks, bigger and better than the insides, next to the Rolls, and the Spirits that first arise out of the Vinegar.

The Accidents which happen to the Workmen, are, 1. Immediate Pain in the Stomach, with exceeding Contortions in the Guts, and Costiveness that yields not to Catharticks, hardly to often-repeated Clysters; best to Lenitives, Oyl of Olives, or strong new Wort. It brings them also to a acute Fevers, and great Asthma's or Shortness of Breath. And these we find effected principally by the Mineral Steams in the casting of the Plates of Lead, and by the Dust of the Flakes: Also by the Steams coming from out of the Heaps, when the Pots are taking up.

Next a *Vertigo*, or Dizziness in the Head, with continual great Pain in the Brows, Blindness, Stupidity, and Paralytick Affections; loss of Appetite, Sickness, and frequent Vomitings, generally of mere Phlegm, sometimes mixed with Choler, to the extremest weakness of the Body; and these chiefly in them that have the charge of grinding, and over the drying Place.

CVII. 1. The Mines of Mercury in *Friuli*, a Territory belonging to the *Venetians*, are about a Days Journey and an half distant from *Goritia* Northwards, at a place call'd *Idria*, situated on a Valley on the *Julian Alps*. They have been, as I am informed, these 160 Years in the Possession of the Emperor, and all the Inhabitants speak the *Sclavonian* Tongue. In going thither we travelled several Hours in the best Woods I ever saw; being very full of Firs, Oaks, and Beeches of an extraordinary thickness, straitness and height. The Town is built as usually Towns in the *Alps* are, all of Wood, the Church only excepted, and another House wherein the Overseer liveth. When I was there in *August* 1664, the Valley and the Mountains too, out of which the Mercury was dug, were of as pleasant a *verdure*, as if it had been in the midst of Spring, which they there attribute to the moistness of the Mercury. That Mine which we went into, the best and greatest of them all, was dedicated to *St. Barbara*, as the other Mines are to other Saints. The usual way down to it is at the beginning not difficult, the Descent not being much; the greatest Trouble is, that in several Places you cannot stand upright: but this holds not long, before you come to descend in earnest by perpendicular Ladders, yet when produced, they do

The Quick-silver Mines in Friuli; By Dr. Walt. Pope. n. 2. p. 21.

not seem to make one Ladder, but several parallel ones. At the End of each Ladder, there are Boards across where we may breathe a little. All the way down, and the Bottom, where there are several Lanes cut out in the Mountain, is lined and propt with great pieces of Fir-Trees as thick as they can be set. They dig the Mineral with Pick-Axes, following the Veins: 'Tis for the most part hard as a Stone, but more weighty; of a Liver-Colour, or that of *Crocus Metallorum*. There is also some soft Earth in which you plainly see the Mercury in little Particles. Besides this, there are oftentimes found in the Mines round Stones like Flints, of several bignesses, very like those Globes of Hair which I have seen in *England*, taken out of an Ox's Belly. There are also several Marcasites and Stones, which seem to have Specks of Gold in them; but upon Tryal, they say, they find none in them. These round Stones are some of them very ponderous, and well impregnated with Mercury; others light, having little or none in them.

The manner of getting the Mercury is this: They take of the Earth, brought up in Buckets, and put it into a Sieve, whose bottom is made of Wires at so great a distance, that you may put your Finger between them; 'tis carried to a Stream of running Water, and washed as long as any thing will pass through the Sieve. That Earth which passeth not, is laid aside upon an heap; that which passeth, is reserved in a Hole, and is taken up again, and put into a second Sieve; and so on to about 10 or 12 Sieves proportionably less. It often happens in the first hole, that there is Mercury at the bottom; but towards the farther End, where the Intervals of the Wire are less, it's found in very great Proportion. The waste Water is so much impregnated with Mercury, that it cureth Itches and other sordid Ulcers. The Earth laid aside, is pounded, and the same Operation repeated. The fine small Earth that remains after this, and out of which they can wash no more Mercury, is put into Iron Retorts, and the Fire forces the Mercury into the Receivers: The Officer unluted several of them; and I observed in all that he first poured out perfect Mercury, and after that came a black Dust, which being wetted with Water, discovered it self to be Mercury as the other was. They take the *Caput Mortuum* and pound it, and renew the Operation. There are 16 Furnaces for this use, each of them carrying 24 Retorts; in all 384 Retorts.

All the Mercury got without the use of Fire, whether by washing or found in the Mines (for in the digging some, the Particles get together, so that in some places you might take up two or three Spoonfuls of pure Mercury) is called by them Virgin Mercury, and esteemed above the rest. The Officer told me, that making an *Amalgama* of Gold and Virgin Mercury, and putting it to the Fire, that Mercury would carry away all the Gold with it, which common Mercury would not do.

The Engines for drawing the Water, are all moved by Water, brought thither in no chargeable Aqueduct from a Mountain three miles distant. The Water pumpt from the bottom of the Mine, by 52 Pumps, 26 on a side, is contrived to move other Wheels, for several other purposes.

The Labourers (being 280 always employed) work for a Julio a Day, which is not above 6 or 7 Pence, and endure not long: For although none stay under ground above 6 Hours; all of them in time (some later, some sooner) become Paralytick, and die Hectick. We saw a Man who had not been in the Mines for above half a Year before, so full of Mercury, that putting a piece of Brass in his Mouth, or rubbing it in his Fingers, it immediately became as white, as if he had rubbed Mercury upon it. Those also that work upon the back side of Looking-glasses, are very subject to the Palsey.

They convey their Wood thus: About four miles from the Mines on the sides of two Mountains, they cut down the Trees, and draw them into the interjacent Valley: higher up in the same Valley they make a Lock or Dam; when the Water is ready to run over it, they open the Flood-Gates, and the Water carries all the Trees impetuously to *Idria*, where the Bridge is built very strong, and at very oblique Angels to the stream, on purpose to stop them, and throw them on shore near the Mines.

Those Mines heretofore cost the Emperor 70000 or 80000 Florins yearly; but now they cost him not above 28000. They produced

Anno 1661.		Anno 1662.	Anno 1663.
	l.	l.	l.
Ordinary Mercury,	198481	225066	244119
Virgin Mercury,	6194	9612	11862
In all	204675	234678	255981

2. The Town of *Idria* in the County of *Goritia* and Province of *Friuli*, is seated low, and encompassed with Hills on all sides. A River of the same Name runs by it, and proves sufficient upon plentiful Rains to convey down the Fir-Trees and other Wood required in the service of the Mines: And to this end there is an handsome Work of Piles made sloping athwart the River (after the same manner as I observed in *Newsol* in *Upper Hungary*, cross the River *Gran*) to stop the Trees.

The Entrance into these Mines is not high, or upon a Hill, but in that Town it self. The deepest part of the Mine from the Entrance, is between 120 and 130 Fathoms.

The Virgin Quicksilver, which they call *Jungfraw*, is that which discovers it self without the help of Fire. Sometimes it is plainly seen in the Ore, or falls down in Drops, and sometimes streams out in good quantity; as about seven Years ago it ran out of the Earth at first in a Stream as small as a Thread, and afterwards as big as a Packthread, but ceased in 3 or 4 Days. That also is accounted Virgin Quicksilver, which is separated only by Water.

Plain Quicksilver they obtain by Fire out of the Ore, or out of the Cinnabar of Mercury, which they dig out of this Mine. The Ore of this Mine is of a dark Colour, mixed with Red.

The Quicksilver Ore of this Mine ordinarily contains half, and sometimes $\frac{2}{3}$ of Quicksilver.

I went into the Mine by the pit of St. *Agatha*, and came up again by that of St. *Barbara*, descending and ascending by Ladders. I ascended at one of 639 Staves, or 89 Fathoms. It has been wrought 200 Years, about the same space of time with *Newfol* Mine, but comes much short in time of the Silver Mine at *Schemnitz*; and much shorter yet of the notable Lead Mines in *Upper Carinthia*.

In a Laboratory, where the Quicksilver is separated by Fire, I saw an heap of 16000 Retorts of Iron; every one of which costs a Crown at the best hand from the Iron Furnaces in *Carinthia*. There are 800 Retorts, and as many Recipients, employed together, in drawing over the Quicksilver in 16 Furnaces; 50 in each Furnace, 25 of a side; 12 above, and 13 below of each side.

June 12. 1669. When I was there, they carried out 40 Saumes of Quicksilver into Foreign Parts, each Saume containing 315 pound Weight, to the value of 4000 Ducats of Gold. Some of it is sent as far as *Cremnitz*, in *Hungary*, for the use of the Gold Mines: And very much carried away Southward; for they are not far from the *Somius*, or *Lysonzo*, a considerable River, which runs into the Gulf of *Trieste* in the *Adriatick Sea*.

In the Castle, I saw 3000 Saumes of Quicksilver together in Barrels; the Quicksilver being first made up in double Leather: And in another House as much Ore as can be distilled in two Years, except they have great Plenty of Rain to bring down the Wood.

The Country is well stored with stately Firs, Larches, Pines, Pinasters, Picea's, and that nobly crisped and well grain'd kind of Acer, whereof Viols and Violins are made: Whereof there is also Plenty in the Country of *Saltzburg* and *Carniola*.

Travelling sometimes in the Night, we had continually about us a great number of large Glow-worms, which put into Papers, give a dim Light like Candles in Lanthorns; and the Air also was full of Flaming Flies, affording some delight unto us.

The way to this Place from *Croatia* I found difficult; and coming from it to *Aidoschini* and *Croatia*, I passed over *Swartzenburg*, or the Black Mountain, from whence I descended 10 miles in a Rocky Country, and far more Stony than the *Craw*, or *Campus lapidosus*, in *Provence*.

Mercury
found in
Plants; By
S. Manfred
Septalius, n.
27. p. 493.

The Incal-
escence of
Mercury
with Gold;
By B. R. n.
122. p. 515.

CVIII. In the Valley of *Lancy*, which runs between the Mountains of *Turin*, grows a Plant like the *Doronicum*, (so also called by the Inhabitants and Botanists;) near the Roots whereof you may find pure Quicksilver, running in small Grains like Pearls; the Juice of which Plant being expressed and exposed to the Air of a clear Night, there will be found as much Mercury, as there is lost of Juice.

CIX. Tho I have many things to object against the Sympathy of Gold with Quicksilver; yet perhaps there may be a Quicksilver more subtle and ponderant

ponderant than that which is common, which may enable the Chymist to argue very speciously for it.

It is hotly disputed among the Curious in Chymistry, whether or no there be any such thing as a Mercury, which being barely mingled with Gold, reduced to fine Parts, will produce any sensible Heat. The Affirmative is asserted by some that pretend to the Transmutation of Metals, who ascribe this Virtue to the Mercuries; extracted, as they suppose, from some compleat Metals; which are therefore, in their Phrase, stil'd *Mercurii Corporum*, or the Mercuries of metalline Bodies. But the Negative is more generally maintain'd, not only by Philosophers and Physicians, but the more learned *Spagyrist*s themselves, especially the Modern.

I the less wonder at this latter Opinion, because having purposely enquired of several prying Alchymists, they have apart ingenuously confessed to me, that they never actually saw any incalcescent Mercury, tho they had sometimes heard it boasted of.

But notwithstanding all this, having for several Reasons look'd upon Mercury as a Body which is not necessarily so homogeneous as it is supposed, the Opinion I most liked of was, that of a Possibility of an incalcescent Mercury. For notwithstanding the vulgarly supposed similar Nature of Quicksilver, which I willingly confess to be great enough to be admirable, yet having devised two ways (unpractised that I know of by any Chymist) the one to discover whether a clean and carefully distilled Mercury might not be a compounded Body, and have in it Parts that are not mercurial; and the other out of such a fine distilled Mercury to separate Parts, and that in no despicable Number, that are plainly heterogeneous: I found upon Trial, that both the Methods I had thought on would succeed; which warranted me to think it possible, that a Mercury very fine and clean, and even purged by Sublimations and Distillations, may, by Art, have been made to assume and incorporate with it a Multitude of heterogeneous Corpuscles, not to be discovered, much less separated (as those of *Tin*, *Lead*, &c. may be) but by a skilful Artist.

This was enough to ingage me to make Trials, whether some of these heterogeneous Particles, that I found reducible with Mercury into a lasting mercurial Flux, might not so alter it, as to dispose it to heat with Gold: And that there were such, thro God's Blessing, my Trials afforded me positive Proof, about the Year 1652.

But when I was alone, that I might not be imposed upon by others, I took to one part of our Mercury sometimes half the Weight, and sometimes an equal Weight of refined Gold reduced to a *Calx*, or subtle Powder. This I put into the Palm of my Left-hand, and putting the Mercury upon it, stirred it, and pressed it a little with the Fingers of my Right-hand, by which the two Ingredients were easily mingled, and grew not only sensibly but considerably hot, and that so nimbly, that the Incalcescence did sometimes come to its height in about a Minute of an Hour, by a Minute Clock. I found the Experiment succeed, whether I took all together, or but half as much

much Gold as Mercury ; but the Effect seemed to be much greater when they were employed in equal Weight.

I tried also the same Mercury with refined Silver, reduced to a very fine Powder ; but I could not perceive any Heat or Warmth at all, tho I am apt to think, with a sufficient Quantity of Leaf Silver, it might have been sensible.

I made Tryal afterwards oftner than once, in the Hands of others, who were not a little surprized and pleased at the Event ; particularly having given the Ingredients to the learned Secretary of the Royal Society, I desired him to make the Experiment in and with his own Hand, in which it proved successful within somewhat less than a Minute of an Hour. (And the L. Viscount *Browncker*, President of the R. S. made the same Experiment with some of the same Mercury, in his own Hand, with good Success.)

This Incalcescence was the more considerable, since being willing to husband my Mercury, I made these Tryals but with a Drachm at a time, which scarce amounts in quantity to the Bigness of half a middle siz'd Bean ; and yet I have sometimes had of this Mercury so subtile, that the Heat made me willing to put it hastily out of my Hand.

However, I will not hence determine, whether those that are *Mercurii Corporum*, and were made, as Chymists presume, by Extraction only from Metals and Minerals, will each of them grow hot with Gold, as, if I much mistake not, I found Antimonial Mercury to do. Nor will I affirm, that every metal-line Mercury, tho ever so disposed to Incalcescence, or even that of Silver and Gold it self, is the same with that which the *Chrysopœan* Writers mean by their Philosophick Mercury, or is near so noble as this. Nay, I will not so much as affirm, that every Mercury, obtained by Extraction, even from the perfect Metals themselves, must needs be more noble and fit, as Alchymists speak, for the Philosophick Work, than that which may with Skill and Pains be at length obtained from common Mercury, skillfully freed from its recrementitious and heterogeneous Parts, and richly impregnated with the subtile and active ones of congruous Metals or Minerals. But if there be any truth in what some of the most approved *Spagyrist*s have delivered about a Solvent of Gold, that seems of kin, and perhaps is not much nobler than one that I had, it seems allowable to expect, that even ours should be of more than ordinary use, both in Physick and Alchymy.

I had almost forgot to tell you, that whereas 'tis usual to take 4, 5, or 6, nay 8 or 10 parts of common Quicksilver, to make an Amalgama with one of Gold, even when both are heated by the Fire ; I found our Mercury so congruous to that Metal, that it would presently imbody with no less than an equal Weight of it, and produce a pretty hard Amalgama or Mixture, in which the Mercury was so diffused, that the Gold had quite lost its Colour. Secondly, I shall add, what for ought I know has not been yet observed, that this Power of penetrating Gold, and growing hot with it, is so inherent, not to say radicated, in our Mercury, that after it had been distilled from Gold again and again, I found it to retain that Property. And Lastly, I found by Tryal, that a single Drachm of Mercury, made after a certain man-

manner, did the 3d or 4th Year after I had laid it by, grow so hot with Gold, that I fear'd 'twould have burnt my Hand.

It may be doubted whether the good that the Preparations of it (such as Precipitates and Turbiths of divers kinds, *Mercurius dulcis*, *Cinnabar* made of the Sulphur of Antimony, and with Gold, &c.) may do in Physick, is likely much to exceed the political Inconveniences that may ensue, if it should prove to be of the best Kind, and fall into ill Hands. The knowledge of the Opinions of the wise and skilful about this Case, will be requisite to assist me to take right measures in an Affair of this nature. And till I receive this Information, I am obliged to silence. In the mean while, I shall make bold to add this Secret, which to some I think will seem a Paradox, namely, That a Mercury qualified to heat with Gold, and perhaps with other Powders, may be made by more Ways than by one or two; Experience having assured me that such a Mercury may be prepared, not only by employing Antimony and solid Metals, as *Mars*, but without any such Metal at all, or so much as Antimony it self.

I shall only admonish those inquisitive Spagyrist, that may be desirous to try, whether their purify'd Mercury be incalcescent, that they be not too hasty to conclude it is not so, nor to reject it, unless they have made the Trial with Gold duly prepared. For the smallest filings of Gold I could make, or even some Calxes of Gold, will not serve our turn, as I have found by employing, without Success, a very fine and spongy Calx, made after an uncommon way; the golden Particles having, as it seemed, some extremely fine tho unobserved Dust of the Additament sticking to them, which hindred the Adhesion of the mercurial ones. Now the Calx of Gold that I most used, as finding it still to do well, was that made by Quartation, as Alchymists call it, that is, by melting together one part of fine Gold, and 3 or 4 parts of cuppell'd Silver, and then putting the Mass, wherein the Metals are mixed almost *per minima*, into purify'd *Aqua fortis*, which dissolving the Silver only, leaves the Gold in the form of a fine Calx. Also, by making an Amalgama with pure Gold and vulgar Mercury, and dissolving the Mercury in good *Aqua fortis*, there will remain a Powder, which being well wash'd in fair Water, to dulcify it and keep awhile in a moderate Fire, to dry it thoroughly without melting it, will become a Calx, which I have more than once used with our Mercury with good Success. I have also sometimes taken, instead of a Calx of Gold, a competent number of Leaves of Gold, reduced by beating only, without the help of Salts, to a sufficient thinness, inso-much that between 70 and 80 Leaves did not weigh a Scruple: and putting 2 or 3 times the Weight of our Mercury to them, I have found, more than once, that a smart Heat was presently produced in my Hand.

CX. There are divers Silver Mines at *Schemnitz* in *Hungary*; but the chiefest and most wrought, are those of *Windschacht* and *Trinity*.

They have no River here, tho much Water in the Mines, so as they are constrained to send much of their Ore to *Hodritz* and other places, where are small Rivers, by which their Bellows and Hammers may be moved, (their

The Silver Mines in Hungary, by Dr. Edward Brown. n. 58. p. 1196.

Ore

Ore pounded, washed, and other Works requisite, performed. To draw about the Engines to pump out the Water, 12 Horses at a time are employ'd to each Wheel: But in *Windschacht* Mine, deep in the Earth, is a large Wheel of 12 Yards Diameter, turned about by the Fall of subterraneous Water; which, together with the other Water, pump'd from the deepest Parts of the Mine, runs thro' a *Cuniculus* made on purpose, at the Foot of the Hill.

Trinity Mine is 70 Fathom deep, built and kept open with under-work at a great Expence. Much of this Mine being in earthy Soil, the Ore of it is much esteemed: Divers Veins lie North; and other rich Veins run to the North-East. When two Veins cross one another, they esteem it fortunate. They use not the *Virgula divina*, and have no certain way to know either which way the Veins run, or where they are, till by the industrious persevering in the Labour of the Mines, they are at last found out. They shewed me one Place, which they had digged straight on 6 Years, when the Ore was but two Fathoms distant from the Place where they began; and in another Place they digged 12 Years outright, and at last found a Vein, which in a short time paid their Charges.

The blackish Silver Ore is esteemed the best; much of it hath a Mixture of a shining yellow Substance or *Marcasite*, which if it be not in too great a Quantity, is not unwelcome; by reason that it disposeth the Ore to Fluidity, or renders it more easy to be melted: But if it be in too great a Proportion, they are of opinion, that it preys upon the Silver in the Mine, and in the Furnace carrieth it away while it melteth, by over-volatilizing it.

There is often found a red Substance, which grows to the Ore, called *Cinnabar*, *Cinnabar* of Silver, *Cinnabaris nativa*, *Minium nativum*, or *Berg-Cinnabar*. This Substance grinded with Oil, maketh a Vermilion, equal to, if not surpassing the *Cinnabar* made by Sublimation. I discovered a Sulphur in it, by casting it upon a hot Iron-Plate, on which it burned blue. The Miners say, they meet not with any Quicksilver, but they find Chrystals, Amethysts, or Amethystine mixtures, in the Clefs of the Rock, and sometimes nigh, or joined to the Ore, as also Vitriol naturally chrystallized in the Earth, in divers of the Mines, and particularly in a Mine in *Paradise-Hill*, near *Schemnitz*.

An hundred Pound Weight of Ore sometimes yields but half an Ounce, or an Ounce of Silver; sometimes 2 Ounces, 3, 4, 5, and unto 20 Ounces. What is richer is very rare, yet some hath been found to hold half Silver; and I have seen it so rich, as to be cut with a Knife.

A Specimen of each sort of Ore, which they dig out of the Mines, is carried to an Officer call'd the *Probiere*, who is to prove and judge of its Richness, which he doth in this manner. Of all sorts of Ores he taketh the same Quantity. The Ores being first dried, burned and powdered, he giveth an equal Proportion of Lead to all, melteth and purifieth them; then by exact Scales, takes notice of the Proportion between the Ore and the Metal contained in it; and reports it to those employed in the great melting Furnaces.

If the Ore be found to hold $2\frac{1}{2}$ Ounces or more of Silver in 100 Pound weight, they ordinarily melt it without any foregoing Preparation, by the help of Iron Stone (which is not Iron Ore, but a Stone found thereabout, of which the Liver-colour'd is the best) *Kys* (a sort of *Pyrites*) and *Slacken* (a Scum or Lake taken off from the top of the Pan, into which the melted Mineral runs, and is a Substance made out of the former mentioned by Fusion;) which are thrown in with it into the melting Furnace.

If the Ore be poorer, holding but two Ounces in 100 Pound weight, or less, it is first pounded and washed, till it becomes richer, or hath a greater Proportion of Metal in respect of the Ore, much of the earthy Parts being washed away. Then it is thrown into the Furnace with the former Materials; and the *Marchafite*, which remains still with it, as sinking always to the bottom with the Silver in the Wash-works, helps to the quicker Fusion of the Ore.

Whatsoever is melted in the melting Furnace, is let out thro a Hole at the bottom thereof, into the Pan which is placed in the Earth before it; and, thus exposed, it immediately acquires a hard Scum, Dross, Loaf, or Cake; which being oft taken off from the top, the Metal remaining in it becomes purer; to which is added Lead, and after some time the melted Metal is taken out. Then being again melted in the driving Furnace, the Lead, or what else remains mixt with the Silver, is driven off by the blowing two great Bellows, and runs over in the form of Litharge. That which first comes over is the white, and that which is last, being longer in the Fire, is the red; not that it is Litharge of Gold; both being driven off from the same Metal.

Most of the *Schemnitz* Silver Ore holds some Gold, which they separate by melting the Silver, then granulating it, and afterwards by dissolving it in *Aqua fortis*, whereby the Gold is left at the bottom, and is afterwards melted. The *Aqua fortis* is distilled from the Silver, and serveth again for Use.

The Silver then separated from all its former Associates, is sent to *Chremnitz*, where they coin it into Pieces of a mixt Metal (which is the common Money of the Country) after this manner: They melt it with about the same quantity of Copper, and run it into Bars, which they beat out; then softening them in the Fire, draw them out to an exact Thinness between two Steel Wheels; then they cut them out into round Pieces with an Instrument like a Shoe-maker's Punch, and then boil them with Tartar and Salt, shake them in a Sack with Small-coal and Water, dry them in a Kettle perforated, and afterwards they are drawn between two Wheels, in which they receive their Stamp.

CXI. Among the 7 Mine-Towns in Hungary (which are not far from one another, viz. *Chremnitz*, *Schemnitz*, *Newsol*, *Koningsberg*, *Bochantz*, *Libeten*, and *Tih*) *Chremnitz* is the richest in Gold. They have also, at present, Gold Mines at *Bochantz* and *Koningsberg*; and they report in that Country, that there hath been formerly a rich Gold Mine at *Glass-Hitten*, but lost since

The Gold Mines in Hungary, by Dr. Edward Brown. n. 53. p. 1192.

since that *Bethlem Gabor* over-run those Parts, when the Undertakers stopp'd up the Mine and fled.

They have worked in the Gold Mine at *Chremnitz* 900 Years. This Mine is several *English* Miles in length, and about 160 Fathoms deep. Many Veins of the Ore run to the North, and to the East. They work also towards one, two, and three of the Clock, as they speak; for the Miners direct themselves under Ground by a Compass, not of 32 Points (such as is us'd at Sea) but by one of 24; which they divide, as we do the Hours of the Day, into twice Twelve. Of the Gold Ore, some is white, and some black, red, or yellow: That with black Spots in white is esteem'd the best, as also the Ore which lieth next to the black Veins. This Ore is not rich enough to suffer any Proof in small Parcels, like that in other Mines, whereby to know what Proportion of Metal is contain'd in it; but they pound a very great Quantity thereof, and wash it in a little River, which runs nigh the Town. The whole River being divided, and admitted into diverse cuts, runs over the Ore continually, and so washeth away the earthy Parts from the metalline: And from a clear River above the Town, by its running thro so many Works, and over so much pounded Ore, it becomes below the Town, a dark yellow Stream, of the Colour of the Earth of those Hills.

There have been Pieces of pure Gold found in the Mine. Some of which I have seen in the Emperor's Treasury, and in the Elector of *Saxony's* Repository; one Piece as broad as the Palm of my Hand, and others less; and upon a white Stone many Pieces of Pure Gold: but these are very rare.

The common yellow Earth of the Country near *Chremnitz*, altho it be not esteem'd Ore, affords some Gold: And in one Place I saw a great part of a Hill digg'd away, which hath been cast into the Works, washed and wrought in the same manner as pounded Ore, with considerable Profit.

Some Passages in this Mine, cut thro the Rock, and long disus'd, have grown up again; and I observed the Sides of some, which had been formerly wide enough to carry their Ore thro, to approach each other, so as we passed with difficulty. This happens in moist Places. The Passages unite not from the top to the bottom, but from one Side to another.

There is Vitriol in this Mine, white, red, blue and green; and also Vitriol Waters. There is a Substance found, which sticks to the Gold Ore, of small pointed parts like Needles, call'd by them *Antimony of Gold*. There are Crystals found here, and some tinctur'd yellow.

The Miners will not allow any Quicksilver or Brimstone to have been found here; yet in the lately mention'd *Antimony of Gold*, there is evidently Sulphur, as I perceiv'd by burning. The Quicksilver Mine, mention'd in the Answer to *Kircher's* Inquiries, *Mund. Subter.* is an *Hungarian* Mile, or seven *English* Miles distant from *Chremnitz*; and is not wrought in at present.

There is a Vitriol Mine in these Hills near the Gold Mine; the Earth or Ore of it is reddish, and sometimes greenish. This Earth is infused in Water, and after 3 Days the Water is poured off, and boiled 7 Days in a Leaden Vessel, till it come to a thick granulated whitish Substance, which
is

is afterwards reduced to a Calx in an Oven, and serveth in the making *Aqua fortis*, or the separating Water used at *Schemnitz*.

They have divers ways of taking the Gold out of its Ore, by burning the Ore, by melting, by adding Silver Ore and other Minerals, Sand, and Lead, as they find the Ore fluid or fix'd. But without Lead they proceed thus :

They break and pound the Ore in Water very fine ; then wash it often, and lay it in Powder upon Cloths, and by the gentle oblique descending of the Water over it, and their continual stirring it, the earthy, clayish, and lighter parts are wash'd away, while the heavier and metalline remain in the Cloths. These Cloths are afterwards wash'd clean in several Tubs, and the Water, after some settling, poured off from its Sediment, which Sediment is again wash'd, and stirred up in several Vessels and Troughs, till at length they sprinkle Quicksilver upon it, and knead it well together for an Hour : and then washing it again in a Wooden Vessel, after the separating of much of it which the Quicksilver touches not, by striking this Vessel against their Leg, they bring the Gold and Quicksilver together, in an *Amalgama*, to one Corner of it. From this *Amalgama* they strain as much of the Quicksilver as they can, thro coarse Cloths first, and then thro fine ; then they put the Mass remaining upon a perforated Plate, which they set over a deep Pan placed in the Earth, in the bottom of which Pan they also put Quicksilver. This Pan they cover, and lute the Cover well : and then making a Charcoal Fire upon it, they drive down the Quicksilver yet remaining in the Gold, to the rest in the bottom of the Pan ; then taking out the Gold, they cast it into the Fire, that it may become purer.

Concerning *Cranach* Gold, I cannot learn that there is any such Gold, or Place where Gold is digg'd, in *Hungary* ; but in *Germany* I think there is, for *Agricola* mentions such a Place as *Golde-Cranacum*, and another call'd *Golde-Crona*.

CXII. It is evident from undoubted Experiment, that Gravity is in all Bodies proportionable to the quantity of Matter in each, and there is no such thing as a Propension of some more, others less, towards the Earth's Center ; since the Impediment of the Air being removed, all Bodies descend, be they ever so loose or compact in Texture, with equal Velocity. It follows therefore, that there is seven times as much Matter in Gold as in a Piece of Glass of the same Magnitude (their Specifick Gravities being nearly as Seven to One) and consequently, that at least six Parts of seven in the bulk of Glass, must be Pore or Vacuity. This some Favourers of the *Atomical Philosophy* have endeavour'd to solve, by supposing the primary or constituent Atoms of Gold to be much larger than those of other Bodies, and consequently the Pores fewer.

In order to examine the Magnitude of those Atoms, I informed my self among Wire-drawers, that the very best double-gilt Wire was made out of Cylindrick Ingots four Inches in circumference, and 28 Inches long, which weigh 16 Pounds *Troy* ; on these they bestow 4 Ounces of Gold, that is, to

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every

*The extreme
Ductility,
and exceed-
ing Minute-
ness of the
constituent
Particles of
Gold. By
Mr. Edmond
Halley. n.
194. P. 540.*

every 48 Ounces of Silver, one of Gold : and that 2 Yards of the Superfine Wire weighs a Grain. Hence at first sight it appeared, that the length of 98 Yards is in weight 49 Grains, and that a single Grain of Gold covers the said 98 Yards, and that the 10000th part of a Grain is above $\frac{1}{4}$ of an Inch long ; which yet may be actually divided into 10, and so the 100000th part of a Grain of Gold be visible without a Microscope. And by means of the Specifick Gravities of the Metals, viz. Silver $10\frac{1}{4}$ and Gold $18\frac{2}{3}$. I found the Diameter of such Wire, the $\frac{1}{3125}$ part of an Inch, and its Circumference the $\frac{1}{15625}$ part : But the Gold in thickness not to exceed the $\frac{1}{3125}$ part of an Inch ; whence it may be concluded, that the Cube of an hundredth part of an Inch would contain above 2433000000 (or the Cube of 1345) of such Atoms. And yet tho the Gold be stretcht to so great a Degree as is here demonstrated, it shews it self of so even and united a Texture, as not to let the white Colour of the Silver under it appear (even with a Microscope) thro any the least Pores ; which argues that even in this exceeding thinness, very many of those Atoms may still lie one over the other.

A Mineral
like Leaf
Gold near
Mexico; By
an English
Gentleman
at Seville, n.
41. p. 817.

CXIII. 1. An. 1664. I travelled into the Kingdom of *Mexico*, under the Character of a *Biscaneer*, and remained in that Country about two Years.

Some of the Mine-men shewed me certain Stones, gathered in great abundance in the Mines of *Tasco*, which they would have to be *Amythysts*.

There is a famous Cave, some Leagues from *Mexico*, on the North-west side of the City beyond the Lake. I found it situated somewhat high, in a place very convenient for Generation of Metals. The Light of a Candle soon discovered to me on all sides, but especially above my Head, a glistering Canopy gilded with a kind of Leaf-Gold. I heaped together a quantity of the Mineral mixt with Sand, and scraped also from the Superficies of the Earth, a quantity of the same kind of Mineral Leaves ; none of which exceed the breadth of a Man's Nail ; and with the least handling they divide themselves into many lesser Spangles ; with a little rubbing they leave ones Hand all gilded over like Gold, and they equalize the most refined Gold upon the Touchstone.

It is reported that the antient *Indians* knew how to make use of this Mineral. But the *Spaniards* have never been able to reduce it into a massy Form by the Violence of the Fire, or separate it from heterogeneous Substances by the mild Tryal of Quicksilver. Some indeed of the choicest Mines of Silver and Gold, are almost of the like nature, till the Impediments are removed, which are certain mineral Viscosities, that sometime by their oleaginous Fatness, and at other times by a fretting Acrimony, hinder the Ingress of the Mercury.

To find out therefore a Cure for this Disease, I began to make Experiment on the Sand, which had been the *Matrix* of the Mineral. I try'd it in a strong reverberating Fire, but it did not afford any visible Fumes. I then boiled

boiled some of it in Water, and having poured that off, I observed the *Alkali* left after the Water's Evaporation : And thereby I discovered, that it abounded rather in sulphureous Unctuousness, than saline Acrimony. Finding this, I applied first the Quicksilver mingled with the ordinary Magistral (as they call them) used in that Country to curb and break the Force of the sulphureous Impediments. But perceiving these to be of no effect, I encouraged the Quicksilver with the *Caput mortuum* of Vitriol or Salt-petre, (kept as a secret among the chiefeest Mine-men) but with as little Signs of the Mercury's Operation as before. Then I boil'd my Mixture over the Fire ; a way found out in *Peru* in such difficult Cases ; but all to no purpose. Then I devised a way to torment it with a corrosive or ordinary separated Water, impregnated with common Salt, and it made a Dissolution exactly like that of Gold : But having steamed away the *Aqua Fortis*, I found a Dirt something yellow, out of which with distilled Vinegar, enforc'd with its own tartareous Salt, I extracted a Tincture more curious than useful.

An experienc'd Mineralist cemented it with the Powder of vulgar Sulphur, *stratum super stratum*, and this in a moderate Fire, for 3 Days together ; hoping the Sulphur would consume all the Impediments, which kept the Mercury from entring : But (as I told him beforehand) it only served to clog the matter with more sulphureous Unctuousity than it had before.

2. When Silver is generated, as commonly 'tis, in certain rocky Stones abounding with bituminous corrosive Mixture, so as 'tis impossible to free it totally from its corrupt *Matrix* by the violent way of melting, whatever auxiliary Ingredient may be added, as Lead and artificial Salts, and the like, because those sulphureous and vitriolick Compounds (in the way of Fusion) meeting together with the Silver, sublime part of it away, in a volatile Fume, by their corroding Acrimony, calcinating and vitrifying the other part, and robbing the Artificer of half his Gain ; in this case the use of Quicksilver is found most advantageous. They practise thus :

The use of Mercury in separating Silver from the Ore ; By the same English Gentleman. ib. p. 820.

Having reduced the Ore into small Stones, they calcine it first in a reverberating Oven, yet with a moderate Fire for fear of Fusion, and driving away into the Air part of the Treasure ; the volatile parts being by nature not perfectly mixt *per minima* with the fixt, as they afterwards come to be by Industry and Art. And I have heard some of the more intelligent Mineralists say, that they judg their metallick Labours and Operations to be many times not so much a reaping of Silver ready made, as a kind of artificial compounding and bettering of that, which Nature had left dispersed and imperfect.

This Calcination serves chiefly to free the Mineral from many Infirmities, that hinder the Operation of the Quicksilver ; and it serves also to discover by the Colour of the Fumes it yields, what corrosive Mixture chiefly abounds in it : Besides that, it renders the Ore more tractable and pliant under the Mill-stone, which is to reduce it to small Flower, before the Application of the Mercury. This is chiefly observed in those Silver Veins, that are of a hard and dry Complexion ; yet those which are usually more soft, abounding

bounding in *Oleaginous Sulphurs*, before burning, are first ground into Powder in such Mills as I have often seen in Glass-houses, and then they receive a gentle Calcination, the Mineralist mingling therewith suitable Ingredients. As if (*e. g.*) the Metal be Sulphureous and Antimonial, Rust and Dross of Iron is found to be an excellent Cure of this Distemper: If Martial, and abounding in Iron, then Sulphur and Antimony reduc'd to Powder. And I have found by Experiment that Sulphur has a particular force to soften and dissolve Iron.

The Ore being ground, calcin'd and curiously sifted, they divide it into several Heaps, and then by lesser Essays, they find out how much Silver is contain'd in every Heap; where'tis very ordinary to find only six Ounces in 100 Pounds; sometimes 12, but if it yield 18, 'tis esteem'd a very rich Vein; yet sometimes there are great Masses found all of pure Silver, which is call'd Virgin Metal. Then proportionable to the Quantity of Silver in each Heap they besprinkle them with Quicksilver, and that not all at once, but at several times, stirring the Ore up and down. If the Mercury gives Signs of being *Tocado* (as they call it) *i. e.* if it appear mortified, not in small and clear spherical Figures (which is a good Prognostick) but in the Form of long Worms of a wan, pale, dark, and leadish Colour, (which indicate that the Ore abounds with Lead and Pewter) it is cured by certain Magistralis which have for their Basis or Master Ingredient calcin'd Copper mingled with Salt.

The Heaps of Ore being thus mingled with Quicksilver, they are often stirred about, the better to incorporate it with the Silver. I find, that they have none but conjectural Signs to know, when the Mercury hath entirely perform'd its Office in separating all the Silver from those heterogeneous Substances; the Uncertainty whereof occasions often very great Losses, especially when they work about Gold; for in passing the right time, the greatest part of the Gold flies away in a Fume. But when by the Colour of the Mercury, coagulated by the Silver in clear massy Lumps, they conjecture the Work done, they wash it by means of three Vessels standing in order the one under the other; so that the Matter in the first and highest Vessel being washed and stirred about with a Mollinet, all the Dust of the heterogeneous Minerals, that imbody not with the Mercury, is carried away together with the Water into the other Vessels, and from thence is quite thrown out by the continual Current of the Water; whereas in the mean while the Silver in clotted Lumps, call'd *Pellas*, is by the weight of the Mercury depressed down to the bottom of the Tubs. Then the Mercury with the Silver is taken out of the Vessels, and diligently squeezed in coarse and strong Linen; and even with Strokes of a Beetle, the Quicksilver is separated as much as may be from the Silver. And this Mass is afterwards reduced, of Molds of the shape of the *Indian Pine Apple*, into a Pyramidal or Conical Figure, which they call *Pineas de Plata*, thus fashion'd for the easier placing them round about the Ridges of a great Earthen Vessel, of the Form of a blind Alembick; round about the Top of which a Fire being made, all the rest of the Mercury forthwith abandons the Silver, and falls to the bottom, from whence it is recovered, and kept for the like use.

Lastly,

Lastly, The Silver is melted down with the *Liga* (as 'tis call'd) which the King of *Spain* allows, by which he returns to the People in Copper that fifth Part, which they allow him of all the Silver.

I have observed, that there is a very strong offensive Smell, ranker than that of Sepulchres, in some Mines; the Workmen telling me, that that is one of the chief Signs of a rich Mine.

A Friend of mine shewed me a very pretty Experiment more curious than gainful; it was a continual budding forth of Silver in the Form of a Branch, in a Glass, over an indifferent strong Fire of Coals; which Sprouts being clipped off with Scissars, and a small Supply of crude Mercury added to the Matter, in a small time there arose another Branch of true Silver, which had sucked and converted into metallick Sprigs a considerable Portion of the Quicksilver. This Motion, and the Increment of new Silver Branches, ceased not, as long as the Fire was continued, and fresh Mercury apply'd, for the due Nutriment of this mineral Vegetation. This whole Complex of Ingredients is known to consist only of vulgar *Aqua Fortis* (abstracted from two Parts of Vitriol, and one of Salt-petre) and Quicksilver, and a small quantity of Silver, far less than you may reap in a small time from these Silver Sprigs: yet Gain there is none, there being more Expences blown away into Smoak, by the continuance of Fire, in one Month, than can be recovered from this Silver Harvest in a longer time.

I am of opinion that in all Transmutation of Metals, the imperfect Metal is not totally transformed into the more perfect, by the Substance mixed with it: But that the Mixture added to the melted Metal, joins it self (as I conceive) to those Parts, which being homogeneous, symbolize together with the Nature of the more perfect, whereby the pure metalline parts are separated from the other heterogeneous impure Sulphurs.

CXIV. The End of Refining is the Separation of all other Bodies from Gold and Silver, which is perform'd four ways, viz. by Parting, by the Test, by the Almond Furnace or the Sweep, and by Mercury. 1. Parting is done with *Aqua Fortis*. Some Refiners, to make the *Aqua Fortis*, take Salt-petre 3 Pound, and *Dantzick* (not *English*) Vitriol 2 Pound (for the *English* Vitriol makes a weaker Water, and a dirty colour'd Verditer, and wholly spoils it.) After they are well bruis'd and mix'd in a Mortar, then distil 100 Pound of the Materials, put into a cast Iron Pot, after this manner.

The Art of Refining: By Dr. Chr. Merret. n. 142. p. 1046.

Build a Furnace 2 Yards high or more; and at the top place in your Iron Pot: To which fit a Head of Earth, like the Head of a large Distillation Alembick for Chymical Oils, which must have a large Belly, branching it self out 8 Inches from the Iron Pot, into 3 Branches; one whereof in the midst, comes directly straight forward's, two other lateral ones come obliquely: All which Branches are 4 or 5 Inches hollow in Diameter, and 5 or 6 long. To these Branches are fitted Glass Bodies, narrow and hollow at both Ends, large and globous in the midst. These must be exceedingly well luted on with Colcothar, Rags, Flower, and Whites of Eggs. To this first Glass Body is luted on another Glass, of the same Figure and Size, and in order 8 alike in

in all, till they come to the Receiver, which is an ordinary Gallon Glass. All these Rows of Glasses lie on Boards, shelving from the Head to the Receiver. The two upper Receivers or Glass Bodies need exceeding good Luting, for the rest ordinary Lute will serve.

The Lute is made of good Loam, some Horse Dung, and a little Colcothar; altho the two former do well.

A little Fire, and that of Newcastle Coals, does the Work. And you need never break or unlute any of the Receivers, but the lowermost.

The *Aqua Fortis* being distill'd off, is put into a large earthen Pot, and there is added of fine Silver, one or two Penny Weight (which is call'd Fixes) to every Pound of *Aqua Fortis*, which within four Hours will purge it from all Dirt and Impurity, and make it fit for Parting, which is thus done.

If their Silver gilt be fine enough for Wire, they only melt it in a Wind Furnace, and cast it melted into a large Tub of Water, that they may have it in small Pieces; but if it be but Standard, they first fine it on the Test. These small Pieces taken from the Water, being well dried, are put into a Glass taper-fashion'd, a Foot high, and seven Inches at the bottom; and then the Glasses are charged with *Aqua Fortis* about two thirds of it, and set in a Range of Iron cover'd two Inches deep with Sand, and a gentle Charcoal Fire is made under it.

Small Bubbles will soon arise, and the Water also run over. If so, they take off the Glasses, and hold them till it does *deservescere*, or else pour out some of it into a Vessel which is at hand.

If Lead be mixt with it, they cannot keep it from running over.

When the Water hath been once quieted from this Ebullition, it will rise no more.

The Greenness of the Water manifesteth the quantity of Copper contained in it.

If the Water boil over, 'twill penetrate the Bricks and Wood.

They commonly let it stand a Night on the Iron Range, with a gentle heat under it, and in the Morning softly pour off the Water impregnated with all the Silver; all the Gold lying like black Dirt at the bottom; which being washed out is put into small Parting-Glasses, and set over the Sand with their Conduit Water for an Hour, and then the Water poured off. This is repeated 5 or 6 times, to separate the Salt from the Gold, which is now fit to be melted, and cast into Ingots.

To regain the Silver, they have large round Washing Bowls, lined within with melted Rosin and Pitch (for otherwise the Water would eat the Wood and penetrate the sides of the Bowl) covered with Copper Plates 10 Inches long, 6 wide, and half or more thick. Into which Bowls they pour good store of Water (the more, the better the Verditer) and then the Silver Water: which working on the softer Metal of Copper, leaves all the Silver in most fine Sand at the bottom, and sides of the Bowl, and Plates of Copper; which being taken out, is washed, dried and melted for any use.

If any Brass or Shroffe Metal be in the Plates, they gather very little of the Silver; the latter mixing with the Silver.

With

With the Copper-water, poured off from the Silver and Whiting, Verditer is made thus. They put into a Tub a hundred pound weight of Whiting, and thereon pour the Copper-water, and stir them together every Day for some Hours together. And when the Water grows pale, they take it out, and set it by for farther use, and pour on more of the green Water; and so continue till the Verditer be made; which being taken out, is laid on large pieces of Chalk in the Sun, till it be dry for the Market.

The Water mention'd to be taken from the Verditer, is put into a Copper, and boiled till it comes to the thickness of Water-gruel, now principally consisting of Salt-Petre reduced, most of the Spirit of Vitriol being gone with the Copper into the Verditer; a Dish full whereof being put into the other Materials, for *Aqua fortis*, is re-distilled, and makes a double Water, almost twice as good as that without it.

2. By the Test, all Metals are separated from Silver except Gold, because *The Test* they swim over it, when they are all melted together.

The Test is thus made. They have an Iron Mould, oval, and two Inches deep. At the bottom hereof are 3 Arches of Iron, set at equal Distances, 2 Fingers wide, if the great Diameter of it be 14 Inches long, and so proportionably in greater or lesser Tests. This Cavity they fill with fine Powder of Bone-Ashes, moistened with *Lixivium*, made with Soap-Ashes. Some use Cakes of Pot-Ashes, or other Ashes well cleansed, and so pressed well together with a Muller, that it becomes very close and smooth at the Top. There is left above, a Cavity in the midst of it to contain the melted Silver. This Cavity is made greatest in the middle, for the Bone-Ashes come up parallel to the Circumference of the Mould, only a small Channel in that end which is most remote from the Blast, for the running off of the baser Metals, and so is made declive to the Center of the Test, where 'tis not above half an Inch deep.

The Test thus made, is set annealing 24 Hours, and then 'tis set in a Chimney a yard high parallel almost to the Nose of a great pair of Bellows; and then therein is put the Silver, which being covered all over with Billets of barked Oak, the Blast begins, and continues all the while strongly. The Lead purify'd from all Silver, (which they call the Soap of Metals) first put in, melts down with the Silver, and then the Lead and Copper swim at the top, and run over the Test; whose Motion the Refiner helps with a long Rod of Iron, drawn along the surface of the Silver, towards the fore-mention'd Slit, and often stirring all the Metal, that the impurer may the better rise. And by continuing this Course, Separation is made in 2 or 3 Hours.

The greatest part of the Lead flies away in Smoke.

If the Lead be gone before all the Copper, 'twill rise in small red fiery Bubbles; then they say the Metal drives, and they must add more Lead. The force of the Blast drives the higher Metals to the lower side of the Test, and helps its running over.

When the Silver is fully fined, it looks like most pure Quicksilver; and then they take off their Sogs, and let it cool. In the cooling, the Silver will

will frequently from the Middle spring up in small Rays, and fall down again. If moist Silver be put into that which is melted, 'twill spring into the Fire.

A good Test will serve 2 or 3 Firings.

So soon as the Silver will hold together, they take it out of the Test, and beat it on an Anvil into a round Figure, for the melting Pot, which being set in a Wind Furnace surrounded with Coal, and covered with an iron Cap that no Charcoal fall into it, is then melted.

If any Dross or Filth be in the Melting Pot, they throw in some *Tinical*, which gathers the Dross together, that it may be separated from it.

These melting Pots are never burned, but only dried, and last a whole Day, if they be not suffered to cool; but if they once cool, they infallibly crack.

*The Al-
mond Fur-
nace.*

3. In the Almond Furnace, or Sweep, all sorts of Metals are separated from Cinders, parts of melting Pots, Tests, Brick, and all other harder Bodies; which must be first beaten into small pieces with a Hammer on an Iron-Plate.

Those which stick but superficially to the Silver, they wash off thus: They have a wooden round Instrument two Foot wide, somewhat hollow in the middle, with a handle on each side; on this they put the Materials, and hold them in a Tub of Water below the Surface; and so waving it to and fro, all the lighter and looser Matter is separated from the Metal.

The Furnace is 6 Foot high, 4 Foot wide, and 2 Foot thick, made of Brick: having a Hole in the midst, at the top 8 Inches over, growing narrower towards the bottom of it, where on the Fore-part, it ends in a small Hole, environed with a Semicircle of Iron, to keep the molten Metal. About the middle of the Back, there is another Hole to receive the Nose of a great pair of Bellows.

When the Furnace is annealed with Charcoal and hot, they throw two or three Shovels of Coals to one of the forementioned Stuff, and so proceed during the whole Work, which continues three Days and Nights, without Intermission. After eight or ten Hours, the Metal begins to run; and when the Receiver below is pretty full, they lade it out with an Iron Ladle, and cast it into Sows in Cavities, or Forms, made with Ashes.

They frequently stop the Passage-Hole with Cinders, to keep in the Heat; and when they think a Quantity of Metal is melted, they unstop the hole to pass it off.

If the Stuff be hard to flux, they throw in some Slag, which is the Recrement of Iron, to give it Fusion.

A stinking blue Smoke proceeds from the Furnace, and all the By-Standers put on the colour of dead Men.

To get the Silver from these Metals, and to refine their Copper from the Litharge, they now use no other Art than that of the Test.

4. By Quicksilver, the filings of Gold and Silver are separated from Dust, &c. This Dust is put into a Hand-Mill with Quicksilver, and being continually turned upon that and the Metals, an Amalgama is made of them, and fair Water poured in, carries off the Dust, as it runs out again by a small Quill.

This Amalgama is put into an Iron, with a Bolt-head set into the Fire, having a long Iron Neck 3 Foot long, to which is fitted a Receiver. The Fire distills off the Mercury into the Receiver, and the Gold and Silver remain in the Bolt-head.

CXV. 1. There was taken of Crown Gold (which is, as they call it, of 22 Kerats Fine, or $\frac{1}{2}$; and the Alloy is part Silver, part Copper, more of the Copper for the most part) to the quantity of 178 Grains. This was melted down with 2 Ounces and 2 Drams of Antimony (about 6 times as much as the Gold.) And because the Gold was put in Plates, for the more certain melting and mixture, the first Regulus of Gold being separated from the Antimony, both were powdered apart, and the Regulus in the Melting-Pot laid upon the same Antimony, and so both melted down again. In both which Meltings, such an Heat was given, as made all of a clear Light, even red hot and boiling. Then the Pot was taken out of the Fire, and all permitted to separate, settle and cool in it. Upon the breaking the Pot, the Gold (being very distinct in the bottom, and easily separated from the Antimony) weighed 163 Grains.

N. B. That this way of cooling all in the Pots was observed in all the following Experiments, for the more certain separation and settlement of the Regulus, without Effusion into the Antimony-Horn, (as they call it) or hollow Iron Cone. Which Effusion by confounding and cooling the Mixture, may be some hindrance to a more perfect Separation. And to be sure, in the bottom of the Cone, there is always a thin Crust of the crude Antimony, troublesome to be separated, without taking off some part of the Regulus.

Note also, that Borax was used in every Pot, for prevention of the sticking of the Regulus to the bottom, and the Antimony to the sides of it, so that both were gotten off clean, and in full quantity.

Of the Regulus, a piece was broken off, which weighed $38\frac{1}{2}$ Grains, and was kept to be refined upon the Coppel apart; the Weight of the remainder therefore was $124\frac{1}{2}$ Grains, which being powder'd and put upon $2\frac{1}{4}$ Ounces of fresh Antimony and melted down, the Regulus weighed 74 Grains.

The other Pieces of $38\frac{1}{2}$ Grains being refined on a Coppel, from the Antimonial Substance mixed with it, (by Exhalation, promoted some time with a blast upon it, especially toward the latter End, as in all the following Experiments of refining upon the Coppel, $30\frac{1}{2}$ gr. and upon melting with Borax in a Crucible) lost not above half a grain. So that the weight of the whole to the Gold it held, was as $38\frac{1}{2}$ to $30\frac{1}{2}$, or the Gold almost $\frac{2}{3}$ of the whole. The latter Regulus weighing 74 gr. being refined in the same manner,

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weighed

By Quick-
silver.

Experi-
ments of
refining
Gold with
Antimony,
by Dr. Jonat.
Goddard, n.
138. P. 953.

weighed 63 gr. the Gold holding proportion to the whole, as 63 to 74; that is, near upon $\frac{3}{4}$ of the whole. So that the same Regulus of Gold and Antimony, in passing thro new Antimony, tho it lose in Weight, yet it is richer in Gold; and appears so to Sense, being of a redder Complexion, more tough and harder to powder.

Both the parcels of Antimony were severally mixed, with equal Weight both of Tartar and Nitre, and then fired, and so reduced to a Regulus. Then the Regulus of each, exhaled and blown off upon Coppels. Of the first parcel of Antimony wherewith the Gold was first melted, the Regulus being exhaled, there remained in Gold 36 gr. Which upon melting in a Crucible, lost somewhat, but scarce half a gr.

Of the second Parcel of Antimony, wherewith the first Regulus of Gold and Antimony, weighing $124\frac{1}{2}$ gr. was melted, there remained in Gold 27 gr.

All the other Parcels were fine Gold to Sense, upon the touch, only that out of the first Antimony was apparently unfine and pale, from the Silver in the original Alloy mixed with it, as appeared by comparing on the Touch-stone, with sovereign Gold allayed with Silver; holding (to the Judgment of Sense) about a 4th part of Silver, as the Sovereign Gold doth a 6th. Neither was it altogether free from Copper; because upon nealing, it always turned black on the Surface. But for the more exact Discovery, it was taken and first refined with Lead upon a Coppel, for separation of any Copper that might be in it. Upon which Operation, it came forth $33\frac{1}{2}$ Grains, which was $2\frac{1}{2}$ Grains less than it was before. Afterwards this last was melted, with betwixt two and three parts of Silver, and so wrought in *Aqua-fortis*, for separation of the Silver: And there remained in Gold but $28\frac{1}{2}$ Grains, and yet it appear'd upon the Touch not fine, but paler than fine Gold, and deeper than Crown Gold allayed with Silver. So that what remained in it, was necessarily of Silver, and it might be estimated about twenty three Kerats fine, or to hold in fine Gold about twenty seven Grains. What loss of Gold was upon this refining with Antimony, may be easily computed. First, $14\frac{1}{2}$ Grains for Alloy, being deducted from the first quantity of Crown Gold, weighing 178 Grains, the Remainder is $163\frac{1}{2}$ Grains. Then the several Parcels of fine Gold, which was recovered, and separated from the Regulus of Antimony and Gold, and also from the Parcels of crude Antimony reduced to Regulus, are to be added together; that is, 30 Grains, 63 Grains, 27 Grains, and 27 Grains, all which amount to 147 Grains, which being deducted from the first quantity of $163\frac{1}{2}$, the difference is $16\frac{1}{2}$ Grains, which is more than $\frac{2}{100}$ or very near a Tenth.

Where and how this loss of Gold ariseth, it appears thus. The first Parcel of the Antimony was charged with $163\frac{1}{2}$ Grains of fine Gold; of which the first Regulus, weighing 163 Grains, (in proportion to that piece of it weighing $38\frac{1}{2}$, and producing upon refining on the Coppel 30 Grains) must hold 127 Grains of fine Gold. Then 27 Grains

of

of fine Gold, estimated to be contained in the 36 gr. separated from this first Parcel of Antimony, being added to the 127 gr. makes 154 gr. which is short of $163\frac{1}{2}$ gr. by $9\frac{1}{2}$ gr. and so much was irrecoverably lost in this Parcel of Antimony.

Then the Piece of Regulus weighing $124\frac{1}{2}$ gr. melted with the second Parcel of Antimony (in proportion to the former Piece broke off, weighing 38 gr. and upon refining yielding 30 gr. of pure Gold) must contain 98 gr. of the like Gold; and so much this second Parcel of Antimony must be charged with. Towards which the Regulus weighing 74 gr. being refined, produced 63 gr. and that Gold, separated from this second Parcel of Antimony, weighing 27 gr. being added, make 90 gr. short of the first Quantity charged upon this part of the first Regulus by 7 gr.

Some loss of Gold may be upon powdering of the Regulus, as also by the Papers necessarily used; but the greatest loss was by small Sparks, which continually fly up, while the Antimony is in a boiling heat with the Gold, many whereof fly over the Pot into the Fire. That these Sparks were Gold appeared thus: when many of them stuck to an earthen Cover, and had coloured it of a deep Red, *Aqua fortis* did not fetch off or dissolve any thing, but *Aqua regis* run off it yellow, like a Solution of Gold in the same Water.

Some loss of Gold may also be upon the firing of the Antimony with Tartar and Nitre, which make a vehement Conflagration with abundant Sparkling.

It hath been suspected that somewhat of the Gold may be dissipated by the Blasts upon the Coppels, in refining it from the Antimony remaining in it. But this is not so probable, because Refiners, to give their fine Gold a higher Colour for gilding, put to it a third or fourth Part of crude Antimony, or of Regulus of Antimony, which is a constant Practice among some of them, and with a great Heat and strong Blast work it off; in which Operation, in some Ounces of Gold, they lose not one Grain.

2. There was taken of Crown-Gold $141\frac{1}{2}$ gr. which was melted with $1\frac{1}{2}$ Ounce of Antimony, and the Regulus weighed 123 gr. from this a piece weighing 30 gr. was broken off, and reserved for refining by it self; the remainder, being 93 gr. was melted down again with the same Antimony, being powdered and put on the top; and thereupon the Regulus came forth, weighing 91 gr. So that here was no considerable Loss. And there is ground to suspect, that it might be upon some accidental Difference in the managing, that the Regulus did not so perfectly separate and settle; for in all other Experiments of melting the same Regulus again with the same Antimony, the Regulus gained Weight.

With the same Antimony. ib. p. 958.

From this second Regulus, a Piece was broken off and reserved for refining apart, weighing 36 gr. the remainder being 55 gr. was melted down, as the former, and in the same Antimony. Whereupon the Regulus came forth in Weight 72 gr. 17 gr. being here gained.

The first Piece of 30 gr. being refined upon the Coppel, produced of fine Gold 24 gr. and the second Piece of 36 gr. produced 28 gr. and the Regulus (upon the third Melting) of 27 gr. produced 55 gr. So that each of the Pieces contained about 4 Fifths of Gold, and but one Fifth of Antimonial Substance in it, yet losing something of that Proportion at each Melting, tho the Regulus gained Weight; both which are contrary, in repeating the Melting of the Regulus with fresh Antimony, as in the former Experiments.

The remaining Antimony being reduced to a Regulus by firing with Nitre and Tartar, as before, and that Regulus exhaled upon the Coppel, there remained of Gold 19 gr. This was less Fine than that fetched out of the first Antimony in the former Experiment. But this Impurity was wholly from the Alloy; and upon refining it, first with Lead upon the Coppel for fetching out the Copper, it weighed $17\frac{1}{2}$ gr. having lost $1\frac{1}{2}$ gr. and then with the *Aqua fortis*, after the melting down with more than the double Weight of Silver, upon which Operation there remained 15 gr. and that not perfect fine, but retaining somewhat of Silver; but finer than Crown Gold allayed with Silver; upon the touch, about 23 Kerats.

The loss of Gold is thus computed. From the first Quantity of $141\frac{1}{2}$ gr. a 12th part or about $11\frac{1}{2}$ gr. being deducted for Alloy, the Remainder is $129\frac{1}{2}$ gr. And the several Parcels of fine Gold produced of the Regulus, according to the Account given in particular, being 24 gr. 28 gr. 55 gr. $14\frac{1}{2}$ gr. all together make $121\frac{1}{2}$ gr. short of the first Quantity by $8\frac{1}{2}$ gr. or very near one Sixteenth.

By exhaling
the whole
Antimony.
ib. p. 960.

3. A parcel of Crown-Gold, weighing $82\frac{1}{2}$ gr. was melting down with an Ounce of Antimony, and the Antimony was exhaled in the Crucible to a Regulus. Then the Antimonial Part of that Regulus was exhaled on a Coppel: Whereupon there remained 84 gr. or $1\frac{1}{2}$ gr. more than the first Quantity. This must happen for want of a Heat strong enough at last to force off all the Antimonial Substance. Whence afterward, upon melting in a Crucible, it came forth 80 gr. the $2\frac{1}{2}$ wanting, being less than the least part of the Proportion of Copper, that must be in it, according to the usual Alloy of Crown Gold. And that there remained Copper in this Gold, appeared by the black Complexion of it upon nealing; as also by the loss upon working it with Lead on a Coppel; whereupon it came forth only 76 gr.

So that Antimony in a far greater Proportion, doth not so much, as Lead, in exhaling or separating Copper from Gold; if the Work be done merely by Exhalation; but doth only retain it with it self, whilst the Gold separates and settles in a Regulus at the bottom. Neither is it so destroyed, but that it may, in part at least, be united to the Gold again.

CXVI. Papers of less General Use, Omitted.

1. Articles of Inquiries concerning Mines ; by Mr. Rob. Boyle. n. 39. p. 530.
2. Some uses of *Vaults* and *Cold Conservatories* in discovering Minerals, n. 56. p. 1139.
intimated, by Dr. Jo. Beale.
3. Several *Coal-Boreings* near *Leeds* in *Yorkshire*, in the Year 1659, for the n. 450. p. 73.
Concerns of a private Family, communicated by Dr. M. Lister.
4. Enquiries concerning *Quarries* and *Stones*, and the antient way of Tem- n. 93. p. 6012.
pering Tools, for cutting *Porphyry* and other hard *Marbles*.
5. Several *Curiosities* relating to *Amber*, lately sent to the R. Society from n. 249. p. 49.
Philippus Jacobus Hartmannus ; and which are now in their *Repository*, at Gre-
sham College.
6. Enquiries about the *Salt-Springs* in *Worcestershire* and *Cheshire* ; by Dr. n. 20. p. 359.
Beale.
7. Queries concerning *Salt Petre*. n. 193. p. 50.
8. The way used in the *Mogul's Dominions*, to make *Salt Petre*. Extrac- n. 6. p. 103.
ted from Mr. *Thevenot's Voyages*.
9. Some *Natural Curiosities* sent the *Royal Society* from *Sicily* ; by Dr. Peter n. 265. p. 632.
Silvester.

CXVII. Accounts of Books Omitted.

1. The *Mundus Subterraneus* of *Athanasius Kircher*.
2. *Admirandorum Fossilium, quæ in Tractu Hildesheimensi reperiuntur, De-* n. 6. p. 109.
scriptio ; Iconibus Illustrata ; D. Frederico Lachmund Hildesheimi, 1669,
in 4to. n. 77. p. 3016.
3. *Lezzioni alla Natura dele Moffette, &c.* Discourses concerning the Na- n. 207. p. 38.
ture of *Damps*, by *Leonardus Capuanus*, a Member of the *Academy* of the
Investigantes. *Naples, 1683.* in 4to.
4. *Dissertationes Medico-Physicæ de Antris Lethiferis ; de Montis Vesuvii In-* n. 219. p. 215.
cendio ; de stupendo Ossium Coalitu, de Immani Hypogastrii sarcomate, a
Bernardo Connor, M. D. Oxon. 1695. in 8vo.
5. *Franc. Travagini, super Observationibus a se factis tempore Ultimorum Ter-* n. 60. p. 1084.
raz Motuum, ac potissimum Ragusiani, Physica Disquisitio ; seu, Gyri Terræ
Diurni Indicium. *Lugduni Bat. 1669.* in 4to.
6. *Historia & Meteorologia Incendii Ætnæi, Anno 1669.* Joh. Alph. Borelli, n. 75. p. 2260.
Regio Julio. 1670. in 4to.
7. *Epistola ad Regiam Societatem Londinensem, qua de Nuperis Terræ-* n. 203. p. 893.
Motibus differitur, & vera eorum Causa eruuntur. *Lond. 1693.* in 4to.
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- n. 40. p. 810. 16. *Scrutinium Chymicum Vitrioli*. Auth. Joh. Georgio Trumphio. Jenæ 1667. in 4to.
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- n. 108. p. 187. 21. 1. *The first Book of the Art of Metals*, written in Spanish by Alonso Barba, &c. and English'd by the Right Honourable Edward Earl of Sandwich, Lond. 1674. in 8vo.
- n. 109. p. 211. 2. *The second Book of the Art of Metals*, wherein is taught the common way of refining Silver by Quicksilver, with some new Rules added for the better performance of the same: written in Spanish by Alonso Barba, and English'd by the Right Honourable Edward Earl of Sandwich, Lond. 1674. in 8vo.
- Ph. Col. n. 3. p. 80. 22. *Prattica Minerale del Marchese Marco Antonio della Fratta*, in Bologna, 1678. in 4to.
- n. 147. p. 189. 23. *Fleta Minor*, or the Laws of Art and Nature in knowing, judging, and assaying, fining, refining, and enlarging the Body of confined Metals, &c. By Sir Jo. Pettus.
- n. 132. p. 814. 24. *A Touchstone for Gold and Silver Wares*, or a Manual for Goldsmiths, and all other Persons, whether Buyers or Sellers, or Wearers of any manner of Goldsmiths Work, &c. By W. B. of London, Goldsmith, in 8vo.
- n. 74. p. 2232. 25. *Joh. Joachimi Becheri Spirensis M. D. Experimentum Chymicum Novum*, quo artificialis & instantanea Metallorum Generatio & Transmutatio ad Oculum demonstratur. Francofurti 1671. in 8vo.

C H A P. IV.

Magneticks.

I. 1. **A** Considerable Loadstone was dig'd out of the Ground in *Devonshire*, which weighed 60 l. It takes up no great weight, yet it moves a Needle about 9 Foot distant. Some part of it was broken off, which being in its proper Place, adds much Strength; for without that, it moves not much more than 7 Foot. Loadstone found in Devonshire; By Dr. Edw. Cotton. n. 23. p. 423.

2. I can assure you, that those Courses, Veins or Loads, where Loadstones are found in the lower parts of *Devonshire* (either as they lie sparingly here and there amongst Iron Ore, or as they lie in considerable Bodies with it) do all generally run East and West; which is contrary to the Imagination of those who have thought that the Loadstone gave a northerly Direction, because its natural Position in its Mine was (as they fancied) North and South. By Mr. J. Beaumont. Ph. Col. n. 1. p. 2.

II. 1. A noble Person did affirm, That a Needle of a Sea-Compass, put in a good Iron Mine (which, he said, yielded 23 Pounds of Metal, out of 120 Pounds of Ore) was not sensibly moved thereby. Magnetical Observations; By n. 23. p. 423.

2. Intelligent Persons say, That all the perfection of our Sea-Compasses, as yet, consisted in this, That the Needle be touched by good Loadstones, and well librated, and that the Variation be truly placed.

3. I have often made Tryal with many Needles, touching them in each Hemisphere of the Stone, with all variety of ways I could imagine, to find if it were possible by that means, to cause any of these Needles to vary in its Direction; but all of them conform'd to the Magnetical Meridian, standing North and South, as other Needles, that were toucht upon the very Pole of the Stone. By Mr. Sellers. n. 23. p. 423. n. 26. p. 478.

All Needles toucht upon different Loadstones of several bignesses and different Virtue, in all parts of the World, agree in this Magnetical Harmony, that they all give the same Directions.

Having sometimes drawn a Needle only over the Pole of the Stone, without in the sphere of its Virtue, without at all touching the Stone; it hath received the same directive Quality, tho not altogether so strong as if it had been really toucht upon the Stone it self. I have also toucht Needles with faint strokes, and other Needles with stronger; all these Needles received the same effect upon the Stone, both for strength and direction. But the nature of the Steel, whereof the Needle is made, and the Temper that is given thereunto, causeth different Effects, as to the strength it receiveth from the Stone. So that I can infuse such Virtue into a piece of Steel, that it shall take up a piece of Iron of 2 Ounces Weight or more; and give also to a Needle, the Virtue of conforming to the Magnetical Meridian, without the help of a Loadstone, or any thing else, that hath received Virtue therefrom.

By Mr. Sam.
Coleprels. n.
27. p. 500.

4. I took a Loadstone unpolish'd, which attracted but meanly; and I heated a Lath-Nail glowing hot, nimbly applying the North Pole of the said Magnet to it, which quickly took it up, and held it suspended. Then I cast the Stone into the Fire, and when it was red hot, I applied the North Pole to another Lath-Nail cold and untouch'd before, which it took up but faintly, yet held it suspended. Two or three Days after, I found that the Loadstone attracted then as strongly, as before it was cast into the Fire.

The Respect
of the Needle
to a
piece of
Iron, held
perpendicu-
lar, in several
Climates; By
--- n.
177. p. 1213.

III. All the way from *England* to 10 deg. North Latitude, the North Point of the Needle respected the upper end of the Iron, and the South Point the lower end, very strongly.

Lat. $9^{\circ} 42'$ N. and Meridian distance from the *Lizard* $9^{\circ} 32'$ W. The S. Point of the Needle did strongly respect the lower end of the Iron, but the N. Point did not so strongly respect the upper end, as before. Lat. $4^{\circ} 33'$ N. and the Meridian Dist. $5^{\circ} 18'$ W. from the *Lizard*, the North Point of the Needle began to decline from the upper end of the Iron, and the South Point to encline more strongly to the lower end. Lat. $00^{\circ} 52'$ S. and the Meridian Dist. $11^{\circ} 52'$ W. from the *Lizard*, the North Point of the Needle would not respect the upper end of the Iron, nor the lower end neither; but the South Point did still incline to the lower end, tho not so strongly.

Lat. $5^{\circ} 17'$ S. and Meridian Dist. $15^{\circ} 9'$ W. from the *Lizard*, the South Point of the Needle would turn to the lower end of the Iron, about two Points; but remove the Iron any farther, and it would fly away from it, and respect the Poles again; but it would not respect the upper end at all; neither would the North Point respect either: But lay the Iron Horizontal, and let the ends of the Iron respect the Poles of the World, and the North Point of the Needle would turn to the South end of the Iron, and contrarily the South Point of the Needle would turn to the North end of the Iron, and alter its respect to the Poles 5 or 6 Points, and no farther; but hold the Iron perpendicular, and put the middle thereof to the Needle, it would still respect the Poles.

Lat. $8^{\circ} 17'$ S. and Meridian Dist. from the *Lizard* $17^{\circ} 35'$ W. the North Point of the Needle would not respect the upper end of the Iron, but rather forsake it, but the South Point would still something respect the lower end, and alter its true Position about 2 Points; but take the Iron and lay it aslope over the Compass, so that the upper end be towards the South Pole, and the lower end to the North, and then the North Point would respect the lower end, and follow it; but if you point the upper end to the North, and the lower end to the South, the North Point will forsake it. But if you lay it Horizontal, it would do as in the foregoing Observations.

Lat. $15^{\circ} 00'$ S. and $20^{\circ} 00'$ W. from the *Lizard*, the South Point of the Needle began to respect the upper end of the Iron, and the North Point the lower end, and followed it about one point; but lay the Iron Horizontal, and the North Point respected the South end of the Iron, and contrariwise, &c.

Lat.

Lat. $20^{\circ} 20'$ S. and $19^{\circ} 20'$ W. from the *Lizard*, the South Point of the Needle respected the upper end of the Iron, and the North Point the lower end pretty strongly, and followed it 3 or 4 Points; but lay it Horizontal, and it would do as before.

Lat. $29^{\circ} 25'$ and $13^{\circ} 10'$ W. from the Meridian of the *Lizard*, the South Point of the Needle respected the upper end of the Iron, and the North Point the lower end strongly.

IV. 1. It's known that a Rod of Iron held perpendicular to the Horizon, ^{The Polarity} or inclining, the lower end is its North Pole, or attracts the South end of a ^{of Iron; By} Magnetick Needle; and that the same end held upwards, becomes a South ^{J. C. n. 214.} Pole, ^{p. 257.} sc. attracts the North end of the Needle, and repels the South end.

I call that a mutable Pole, which may be North or South, as you hold it; and a fixt Pole that which does not change however you hold it.

2. The Species of the Pole, whether North or South, may be found by passing the Iron Rod thro Cork or Wood, and then leaving it to swim on Water, it will turn to its proper Pole: But this way is slow and not nice. A better way to try, for instance a North Pole, is to hold the Iron perpendicular to the Horizon, and to try whether being held under the North end of the Needle, it attracts it. But a yet better way is to try whether the upper end of the Rod attract the South end of the Needle: for Attraction is more sensible than Expulsion.

3. A fixt North Pole may be made with all the Ways and Rods that you can make a fixt South Pole; but not *vice versa*, for there are many Cases wherein you can make a fixt North Pole, but not a fixt South Pole: And whatever way you get a fixt South Pole, 'tis weaker than a fixt North Pole made the same way. Applying a Needle to an erect Bar, beginning at the top, and so down, the Needle turns not at the middle, but nearer. Of some Rods you cannot make a fixt South Pole primarily, yet you may consequentially; so you may make one end a fixt North Pole, and then the other end of those Rods may, without more to do, become a fixt North Pole. But this does not always hold, for the one may be a fixt North Pole, and the other may be a mutable Pole.

4. Fire destroys all fixt Poles, sc. whether made by the Magnet, or other-ways; but it increases, or rather less hinders that Magnetism, which proceeds from the Earth; sc. a Wire or Rod of Iron heated at one end, that end is a mutable Pole, but more vigorous while hot than cold. The Vigour of mutable Poles is more in great than little Rods; but 'tis otherwise in fixt Poles.

5. Heat the end of a Rod of Iron red hot (or heat all the Rod) and cool that ignited end Northward, it will be a fixt North Pole; if cooled South it becomes a fixt South Pole. This say *Gilbert* and others from Experience: But I say this holds but in some cases; sc. if the Rod is short, you cannot make a fixt Pole that way. Take a round Wire whose Diameter is $\frac{1}{4}$ Inch, and length 10 Inches, you cannot produce a fixt Pole by Ignition; but if this Wire were longer, as suppose 30 Inches long, or never so much longer,

H h h h 2

'tis

'tis capable of a fixt Pole by Ignition. Again, take a round Rod 30 Inches long, and 1 Inch Diameter, this Rod is not capable of a fixt Pole at that Length, tho the lesser was capable at that Length. And so my Experiments give me reason to think, that there is no Rod nor Bar of Iron ever so thick, but which if it had Length enough would be capable of a fixt Pole by bare Ignition; for of that I only speak in this Paragraph: And there is no Rod ever so short, but which if you make it sufficiently thin, is capable of a fixt Pole. So when in a Rod I could not obtain a fixt Pole at 21 Inches length in that thickness, I could, by making the Rod thinner, produce a fixt Pole even in the length of one Inch and less, and the Pole should be of what kind I pleased. The *Terminus*, or necessary length, for every thickness, increases more than you would be apt to think.

6. Heat a Rod, or its end red hot, and thoroughly cool this end downwards or towards the *Nadir*, it will have somewhat more Magnetism than if cooled Horizontally towards the North. But the better way is to cool it a little inclining towards the North. I cannot find that multiplicity of Ignitions does produce more Magnetism than one good Ignition; but it must be thoroughly ignited. Nor can I find by many Experiments, what quenching in Water signifies to the producing or hindring Magnetism; but many Ignitions may accidentally promote it by purifying the Iron.

7. Dr. Power says, that if we hold a Rod Northward, and hammer in that Position the North end, that will become a North Pole, *i. e.* a fixt North Pole: contrarily if you hammer the South end. But this is true (as I said before of Ignitions) only in Rods of a certain length and thickness.

8. What is said of Hammering is to be understood of Filing, Grinding, Drilling, Sawing: Yea, a soft rubbing, provided it is long, will produce fixt Poles. The more heavy the Blows are, *ceteris paribus*, the Magnetism is more. I say, *ceteris paribus*, as when the Blows be not so heavy in either Case as to flat; for flattening the Iron produces more Magnetism, tho other things don't vary. A few hard Blows will produce as much Magnetism as many, yet a soft Blow may produce but little Magnetism. The utmost Magnetism that I could produce in ordinary Rods this way, did not exceed that which an ordinary Loadstone would have infused.

9. Beating many Rods Northward, whose lengths I knew sufficient, I never failed of producing a fixt North Pole; but hammering the same or like Rod Southward, I found that I could not produce a fixt South Pole, only a mutable Pole; nay hammering one full South, I produced a fixed North Pole. Then I thought the Reason might be, that the hammer'd South end on the Anvil was a little lower than the end which I held in my Hand: Then I held the end higher, and so hammering it South upwards, I never failed producing fixt South Poles in proper Rods.

10. Old Drills and Punches are fixt North Poles, because a'most constantly used downwards: But new Drills are either mutable Poles, or weak North Poles. When I say a new Drill, I don't mean one made on the Spot, for that is probably a North Pole, because quench'd downwards in Water; but then such Polarity made by bare Ignition, is a weak Pole, and

and soon decays and turns to a mutable Pole : But I mean a Drill, which tho never or little used, yet has been made some Days or Weeks. Drill with this Southward Horizontally, and 'tis a Chance if you produce a fix'd South-Pole, but much less, if you drill South downwards : But if you drill South upwards, you may make it a fix'd South-Pole.

11. The stronger the Polarity is, the longer it will last. A weak fix'd Pole may degenerate into a mutable Pole in a Day's time ; yea I have known it in a few Minutes, while expos'd to the Air, and held in a Position contrary to its Pole ; on the contrary, we find Needles touch'd with good Loadstones, hold that Virtue a great while, if kept from Air, and in a meridian Site.

12. The Loadstone it self will not make a fix'd Pole of any Iron ; it must have a proper Length if 'tis thick ; or if 'tis short, it must have a sufficient thinness. So ordinary or weak Loadstones cannot fix a Pole in a thick short Key, which yet they will do in a little Key. So in a short thick Iron tapering, a Loadstone may fix a Pole in the little End, when it cannot in the great End.

13. When Ignition, Hammering, or a Loadstone cannot make fix'd Poles, it must not be thought that it can do absolutely nothing on such Rods ; for even then it may be found, that there's an Effect of Magnetism in them discernable enough otherwise, tho not enough to make fix'd Poles.

14. When you have the due Length for making of a fix'd Pole, you will find the making one a fix'd North will consequently render the other a fix'd South Pole : But if keeping the same Diameter of this Rod, you increase its Length enough, the making one End a fix'd North Pole will not necessarily make the other a fix'd South Pole, but leave it a mutable Pole. So if you by a like primary Operation make the second End a fix'd Pole, the first End will lose its Fixity, and become mutable.

I say, there's a certain Length suited to every Thickness of Iron ; to leave one End mutable, while the other is fix'd, and the thicker the Iron is, the greater is the Length.

15. If you farther increase the Length of the same Rod, you will attain such Length, that when you have fixed a Pole on one end, and then go to fix the other end, the Fixity of the first will not be destroyed, and that end become mutable as before ; but the Fixity of the first End will remain, and so you make both Ends two fix'd North Poles, or 2 fix'd South Poles. I say, the shortest Length, (for there's no Terminus of the greatest Length) for this is more in thick than in thin Iron.

16. The aforesaid Lengths are less, according to the Strength of Magnetism ; sc. Ignition requires a greater Length than when a Rod is actuated by a Loadstone, and a Rod touch'd with a strong Loadstone requires less Length than one touch'd with a weak one.

V. 1. I caus'd 6 or 7 several Drills to be made before my Face, and the Bit or Point of every one became a North Pole, only by hardening, before they ever came to be work'd, either in Iron or any other Matter, so that I cannot suppose

By Mr. Baily.
lard, n. 246.
p. 417.

pose those found in a Shop to have gotten their Polarity so much from their After-use as from their first Make.

2. That Pieces of plain Iron, in shape like Drills, (that is something long and small) do always change their Poles as they are inverted, the end downwards being ever the N. Pole, I find not always true: for tho it hold generally in such small Pieces, and always (as far as I can yet find) in Pieces of any Bulk, as large Hammers, Anvils, Andirons, Bars of Windows, &c. yet I found several small Pieces of Steel, such as the Drills are made of, to have fixed Poles, one end *North*, the other *South*, in whatever Postures I held them. Some of these were very vigorous in such their Polarity, others shew'd plainly a Tendency to such a Pole, rather than the other, yet so faintly, that it applied contrary to their Inclination, (that is at the upper End, if it affected to draw the *South*, or the lower End, if the *North*;) They caused the Needle to stand in *Æquilibrium*, East and West; the particular Inclination of one End seeming, in some Pieces, quite to conquer; in others, quite to hinder that more general Polarity they both acquire, by being either upward or downward. Yet this seems only to be found in small Stems of Iron; the being either upward or downward always prevailing in Pieces of greater Bulk.

3. I took my Knife which had been touch'd a quarter of a Year or more before, and profering it to the Needle, it drew the *North-Pole*; which happen'd right for my purpose: I whetted it briskly on a dry dirty Threshold, and being thin, it became very hot towards the Point, the Edge being whet away to a Wire, as they term it, I struck the very top, and back towards the top against the Ground, as I had done the Sides, to destroy and rub off, if I could, all its former Polarity, which was *Southward*: then offering it again to the Needle, it drew the *South End*, and was quite changed. To confirm the thing, I touch'd the same Knife again with the *North Pole* of my Loadstone, and it drew vigorously the *North End* of the Needle. I whetted it again strongly in the same manner, and it changed again. This I repeated 5 or 6 times, and it still changed by whetting, especially on the Sides towards the Top of the Knife; the very Top and Back, which could not be whet to so great an Heat, retaining still some Affection for that Pole the Loadstone had inclined them to. This I tried with a Knife of a thicker Blade; but I could not with my Hand whet it to that Heat, as to have the same Effect wrought upon, as my own: tho I used such Force as at last to break it in two.

4. I suppose that bare drilling might be able to give a Polarity to a Drill, if it could be made indifferent, as well as Filing does, if the Drill be used so briskly as to be made as hot as the File makes the Iron. And tho a *South-Pole* given by the Magnet cannot be taken off by the Heat of a brisk Motion, as that of drilling, which yet by the Experiment of my Knife seems to be contradicted; yet perhaps the Heat may be great enough to produce a Polarity in an indifferent Piece of Iron, as may be done in little indifferent Drill-like Pieces of Steel, by Filing.

5. Two Degrees to the Northward of the Line, the North Point of the Needle did incline 8 Degrees downwards; but as we went to Southward, it was inclined above 48 Degrees upward.

VI. 1. An. 1666. Jan. 13. In Rownham Meadows near Bristol, by the Water side, Capt. Sturmy took the following Observations,

The Declination of the Needle, observed by Mr. Ja. Cunningham, n. 264. p. 577. Magnetical Variations, near Bristol; by Capt. Sa. Sturmy. n. 37. p. 726.

☉ Alt.	Magnetick Azimuth	☉ Azim.	Variation Westerly.
44° 20'	72 00'	70° 38'	1° 22'
39 30	80 00	78 24	1 36
31 50	90 00	88 26	1 34
27 2	95 00	93 36	1 24
23 20	103 00	101 23	1 23

In this Table, he notes the greatest Difference to be 14'. and taking the Mean for the true Variation, he concludes it then and there, to be just 1° 27'. He observed again in the same Day of the next Year, viz. June 13. 1667. and then he found the Variation encreased about 6 Westerly.

2. An. 1630. I traced 3 different Meridian Lines in several Places of Paris, and found, that the Needle declined $4\frac{1}{2}$ deg. North-East, which having published and made known here to the Curious, and to Artists, some of whom counted 9 or 10 deg. according to the Tradition and Writings of Orontius Fineus, and Castle Franc; others, $11\frac{1}{2}$ deg. following Sennertus and Offusus: all at first rejected my Observation, and as commonly new things meet with Obstacles and Contradictions, before they are establish'd, those that could not contradict what they saw, pretended that this Variety did perhaps proceed from the greater or lesser Vigour in the Loadstones employed to touch with, or from thence, that the Needles had been touch'd nearer to or farther from their Poles.

At Paris, by M. Petit, n. 28. p. 527.

To remove the Objections, and to try another Quality which Gilbert had assigned to Terella's, I caused a Magnet to be turned with the Powder of Emery, till it became a spherical half Inch in Diameter, its 3 Centers of Magnitude, Gravity and Strength being the same, with so much Justness, that after I had exactly found the two Poles of this Stone, I caused 2 small Holes to be made therein, to support it by two Points of Needles, as by two Pivots; which having put in a Meridian of Brass, and suspended the Ball betwixt them

a little Globe, it was so easily moveable, that I made it turn every way with a Blast only of my Mouth, and it stopped indifferently, now in one, then in another Place, not any side of it prevailing.

This Stone, being thus prepared without any Defect in Virtue or Figure, uniform, homogeneous, equilibrated, was adjusted on its Meridian and an Horizon, and so placed on its Meridian Line, that the Poles thereof answered to the Poles of the Heavens. The Success was that it had not any Motion at all: whence I thought the Proposition of *Gilbert*, that such a Stone so posited would turn round in 24 Hours, was sufficiently refuted.

This Stone, together with others (whereof the Poles were well mark'd) served me also to find out, whether the Needles touched in different Places, nearer to or farther from the Poles, had different Declinations. Which having tried frequently, I found no Difference at all in the Declination of the Needles, but all of them declined then from the Meridian $4\frac{1}{2}$ deg. from the North-Eastward. I also found it to be the same in many Places, from *Brest* in *Britany* to the *Valoline* amongst the *Alps*. I believed at first, that the Antients had ill observed the Variation; but I was soon undeceived of this Error, by the Observations in *England*, of *Mr. Burrows*, An. 1580. of *Mr. Gunter*, An. 1612. and of *Mr. Gellibrand*, An. 1633. which did assure me, that those Declinations were not constant.

And that I might be convinced by my self, in *June* An. 1660, after I had very exactly traced a Meridian by many Azimuths, before and after Noon, with a Brass Quadrant of 6 Foot Diameter, and applied good Needles upon it; the one of 7, the other of 10 Inches long, I found that they declined but one Degree, or thereabout: And the last Year (1666) I found no more but 10 Minutes on the same Meridian. And methinks that the Declination this Year (1667) is still less, but yet some Minutes towards the East, at least at *Paris*. But I doubt not but in 12 or 15 Years the Declination will be $1\frac{1}{2}$ deg. North-west: As I have prognosticated by my Hypothesis, which maketh the Declination to vary a Degree every 7 or 8 Years.

At Rome,
by M. Auzout, n.
58. p. 1184.

3. An. 1670. *M. Adrian Auzout* made the following Observation here at *Rome*, on many meridian Lines, with a Needle about 6 Inches long, and on all the Lines it was seen to decline somewhat more than 2 deg. Westward, and on some near $2\frac{1}{2}$ Degrees. But by the Observations here made formerly, it appears, that the Needle hath declined Eastward to 8 Degrees, and hath afterwards been diminishing, until it comes to the other Part, where we find it at present.

It seems not, that this Difference of 10 deg. and more, can be attributed to the change of the Pole of the Earth, or to the Magnet, or to the Iron, that are found in certain Places, because there is but little Loadstone; and *M. Auzout* affirms, that the Mines which he hath seen, make no Impression at all on the Needle, so that 'tis difficult to hit the true Cause of such a Variation: Yet however, if the Direction of the Magnet, and of the Needle touched by it, depends upon the Flux of a certain Matter, passing thro the whole Earth, or the exterior Parts of it, strait along the Axis, it may be said, that it proceeds from Changes made in the said Flux, which supposing the Inequalities

lities of the Earth, and the Alterations made continually therein, as well artificial by Excavations, and such like other Works, as natural by Corrosions, caused by Fire and Water, or by the Generation of Metals and Stones; besides the various Changes we cannot think of, by reason of the little Knowledge we have of so vast a Body as the Earth, cannot but in progress of time change its Situation. The Inequalities of the Earth may in time occasion some bending in the Current of this Magnetick Matter, and make it change its Bed and Channel; whence it comes to pass, that the Needle changeth its Direction, according as the Current changeth which directs it. And if it should be so, there would be no hopes of finding a regular Hypothesis for that Change; forasmuch as it would depend upon Causes that have no Regularity at all in them, as most of the Mutations of Nature are.

4. *An.* 1642. I observed the Declination of the Magnet here at *Dantzick*, as did *M. Linnemannus* about the same time at *Koningsberg*, and we both found the Magnetick Needle at that time to decline from the North 3 deg. 5 min. Westw. As Dantzick by Mr. Hevelius, n. 64. p. 259. But now (*Jan.* 22. 1670. *S. N.*) it is far otherwise, for it declines at present, as I have very carefully observed, 7 deg. 20 min. to the same Quarter; so that in the space of 28 Years, that Declination is increas'd 4 deg. 15 min. In the Year 1628, if I remember aright, I found it near 1 deg. Westw. which Declination was affirm'd by the learned *Petrus Crugerus* (once my worthy *Præceptor*) to have been about the beginning of this Age, or the end of the next foregoing, 8 deg. 30 min. Eastw. Hence it appears, that this Declination of the Loadstone doth here, at *Dantzick*, encrease each Year to 9 min. 6 sec. which is sufficiently confirm'd by the Observations made at *Lime-House*, near *London*, by those three famous *Englishmen*, *Burrows*, *Gunter*, and *Gellibrand*. Of whom the First found the Declination *A.* 1580. to be 11 deg. 16 min. the Second, 5 deg. 36 min. 30 sec. *An.* 1622; the Third 4 deg. 3 min. 30 sec. *A.* 1634.

I cannot yet devise any cause of those Appearances, except we impute them to a kind of Libration in the Motion of the Earth, and the Variation of the Meridian.

5. The last Summer 1680, I was present with *Dr. Geo. Volcamer*, at *Nuremberg*, while he was making some Observations and Trials with his Magnetical Needle. He repeated the Trials several Days one after another, and with various ways of Examination, but still in every of them, with the same Success; he most certainly found, that the North-End of the Magnetical Needle (which the former Age always reported to us, to vary from the North, and to direct or point more towards the East, by several Degrees) did now decline towards the West near 5 Degrees. As Nuremberg in Germany, by Joh. Chr. Sturm. Ph. Col. n. 2. p. 8.

An. 1685. Sub initium Mensis *Augusti*, de certitudine Meridianarum omni qua fieri potuit cura ex circumspectione securi redditi, applicatis variis Pyxidibus Magneticis, tam iis vetustioribus, quæ ante quinquennium huic usui adhibebantur, quam aliis recentioribus plurimis, mediocris quidem Longitudinis, quarum maximæ semissem Pedis non excedebant, sed gracilioribus & vivacibus, animadvertēbamus, quod mirum, Declinationem *Acus* a pristina nec in uno minuto discrepare, sed in quavis *Meridiana* exacte cum priori convenire, ad *Occas.* *Scil.* 5 deg. 5 min. *An* autem interea temporis

ulterius processerit, aut nunc in situ retrogrado ejus deviatio deprehensa fuerit, quod certe casu evenisse potuisset, non liquet, cum nec temere istud statuere, quin in eam sententiam, quod stationarius (proculdubio circularis Motus) in eodem puncto permanferit, pronius abire velimus.

*On the Coast
of Guinea,
by Mr.
Heathcot.
n. 158. p.
578.*

7. An. 1683. the magnetical Variation here at *Cabo Corse-Castle*, was 3 deg. 49 min. from the North to the Westward.

*Magnetical
Variations
predicted by
Mr. Henry
Bond, n. 40.
p. 789.*

VII. Mr. *Henry Bond* having entertain'd an Hypothesis of the Variations of the Needle, hath (for the Examination of it) calculated the following Table.

Years.	Variation West.	Years.	Variation West.	Years.	Variation West.	Years.	Variation West.
1663	1°—56'	1701	7°—19'	1706	8°—1'	1711	8°—41'
1670	2—18	1702	7—28	1707	8—9	1712	8—49
1680	4—00	1703	7—36	1708	8—17	1713	8—56
1690	5—39	1704	7—45	1709	8—25	1714	9—4
1700	7—10	1705	7—53	1710	8—33	1715	9—11

*A Theory of
the Magne-
tical Varia-
tion, by Mr.
Edm. Halley.
n. 148. p.
208.*

VIII. Before I proceed to the Theory of the Variation of the Magnetical Compass, it is necessary to lay down the Grounds upon which I raise my Conclusions; and at once to give a Synopsis of those Variations which I have reason to look upon as sure, being mostly the Observations of Persons of good Skill and Integrity.

Names of Places.	Long. from London.	Latitude.	An. Dom.	Variation observed.
London	0° 0'	51° 32' N	1580	11° 15' E
			1622	6 00 E
			1634	4 5 E
			1672	2 30 W
			1683	4 30 W
Paris	2 25 E	48 51 N	1640	3 00 E
			1666	0 00
			1681	2 30 W
Uraniburg	13 00 E	55 54 N	1672	2 35 W
Copenhagen	12 53 E	55 41 N	1649	1 53 E
			1672	3 35 W
Dantzick	19 00 E	54 23 N	1679	7 00 W
Mompeliev	4 00 E	43 37 N	1674	1 10 W
Brest	4 25 W	48 23 N	1680	1 45 W
Rome	13 00 E	41 50 N	1681	5 00 W

Bayonne

Bayonne	1 20 W	43 30 N	1680	1 20 W
Hudson's Bay	79 40 W	51 00 N	1668	19 15 W
In Hudson's Streights	57 00 W	61 00 N	1668	29 30 W
In Baffin's Bay at Sir Tho. Smith's	80 00 W	78 00 N	1616	57 00 W
At Sea (Sound)	57 00 W	38 40 N	1682	7 30 W
At Sea	31 30 W	43 50 N	1682	5 30 W
At Sea	42 00 W	21 00 N	1678	0 40 E
Cape St. Augustine off Brasil	35 30 W	28 00 S	1670	5 30 E
Cape Frio	41 10 W	22 40 S	1670	12 10 E
At Sea off of the Mouth of the River of Plata	53 00 W	39 30 S	1670	20 30 E
At the East Entrance of the Magellan Streights	68 00 W	52 30 S	1670	17 00 E
At the West Entrance of the Magellan Streights	75 00 W	53 00 S	1670	14 10 E
Baldivia	73 00 W	40 00 S	1670	8 10 E
At Cape d'Agulhas	16 30 E	34 50 S	1622	2 00 W
At Sea	1 00 E	34 30 S	1675	8 00 W
At Sea	20 00 W	34 00 S	1675	0 00
At Sea	32 00 W	24 00 S	1675	10 30 E
At St. Helena	6 30 W	16 00 S	1677	10 30 E
At Ascension	14 30 W	7 50 S	1678	0 40 E
At Johanna	44 00 E	12 15 S	1675	1 00 E
At Mombasa	40 00 E	4 00 S	1675	19 30 W
At Zocatra	56 00 E	12 30 N	1674	16 00 W
At Aden, at the M. of the R. Sea	47 30 E	13 00 N	1674	17 00 W
At Diego Roiz	61 00 E	20 00 S	1676	15 00 W
At Sea	64 30 E	0 00 S	1676	20 30 W
At Sea	55 00 E	27 00 S	1676	15 30 W
At Bombay	72 30 E	19 00 N	1676	24 00 W
At Cape Comorin	76 00 E	8 15 N	1680	12 00 W
At Ballasore	87 00 E	21 30 N	1680	8 48 W
At Fort St. George	80 00 E	13 15 N	1680	8 10 W
At the West Point of Java	104 00 E	6 40 S	1676	8 10 W
At Sea	58 00 E	39 00 S	1677	3 10 W
At the Isle of St. Paul	72 00 E	38 00 S	1677	27 30 W
At Van Diemen's Land	142 00 E	42 25 S	1642	23 30 W
At New Zealand	170 00 E	40 50 S	1642	0 00
At 3 Kings Isle in New Zealand	169 30 E	34 35 S	1642	9 00 E
At the Isle Rotterdam in the S. Sea	84 00 E	20 15 S	1642	8 40 E
On the Coast of New Guinea	149 00 E	4 30 S	1643	6 20 E
At the West Point of New Guinea	126 00 E	0 26 S	1643	8 45 E
				5 30 E

By this Table it appears,

First, That in all *Europe* the Variation at this Time is West, and more in the Eastern Parts thereof than the Western; as likewise that it seems throughout to be upon the Increase that way.

2. That on the Coast of *America*, about *Virginia*, *New England*, and *Newfoundland*, the Variation is likewise westerly; and that it increases all the way as you go northerly along the Coast, so as to be above 20 deg. at *Newfoundland*, nearly 30 deg. in *Hudson's Streights*, and not less than 57 deg. in *Baffin's Bay*; also that as you sail Eastwards from this Coast, the Variation diminishes. From these two it is a *Legitimate Corollary*, That somewhere between *Europe* and the North Part of *America*, there ought to be an easterly Variation, or at least no westerly; and so I conjecture it's about the eastermost of the *Tercera Islands*.

3. That on the Coast of *Brasil* there is East Variation, which increases very notably as you go to the Southward, so as to be 12 deg. at *Cape Frio*, and over-against the River of *Plate* 20 $\frac{1}{2}$ deg. and from thence, sailing South-westerly to the *Streights of Magellan*, it decreases to 17 deg. and at the West Entrance it is but 14 deg.

4. That to the Eastward of *Brasil* properly so called, this easterly Variation decreases, so as to be very little at *St. Helena* and *Ascension*; and to be quite gone, and the Compass to point true about 18 deg. of Longitude, West from the Cape of *Good-Hope*.

5. That to the Eastward of the aforesaid Places, a Westward Variation begins, which reigns in the whole *Indian Sea*, and arises to no less than 18 deg. under the *Æquator* it self, about the Meridian of the Northern Part of *Madagascar*, and near the same Meridian; but in 39 deg. South Latitude, it is found full 27 $\frac{1}{4}$ deg. from thence easterly, and West Variation decreases, so as to be but little more than 8 deg. at *Cape Comorin*, and then 3 deg. upon the Coast of *Java*, and to be quite extinct about the *Molucca Islands*, as also a little to the Westwards of *Van Diemen's Land*, found out by the *Dutch* in 1642.

6. That to the Eastward of the *Molucca's* and *Van Diemen's Land* in South Lat. there arises another easterly Variation, which seems not so great as the former, nor of so large Extent; for that at the Island *Roterdam* it is sensibly less than upon the East-Coast of *New Guinea*: and at the rate it decreases, it may well be supposed, that about 20 deg. farther East, or 25 deg. East Long. from *London*, in the Latitude of 20 deg. South, a westerly Variation begins.

7. That the Variations observed by the Hon. Sir. *John Narborough*, at *Baldivia*, and at the West Entrance of the *Streights of Magellan*, do plainly shew, that the East Variation noted in our 3d Remark is decreasing apace, and that it cannot reasonably extend many Degrees into the *South-Sea* from the Coast of *Peru* and *Chili*, leaving room for a small westerly Variation in that Tract of the unknown World, that lies in the Mid-way between *Chili* and *New-Zealand*, and between *Hound's Island* and *Peru*.

8. That in sailing North-west from *St. Helena*, by *Ascension*, as far as the *Equator*, the Variation continues very small East, and as it were constantly the

the same ; So that in this part of the World, the Course wherein there is no Variation, is evidently no Meridian, but rather Northwest.

9. That the Entrance of *Hudson's Streights* and the Mouth of the *River of Plata*, being nearly under the same Meridian, at the one Place the Needle varies $29\frac{1}{2}$ deg. to the West, at the other $20\frac{1}{2}$ deg. to the East. This plainly demonstrates the Impossibility of reconciling these Variations by the Theory of *Bond* ; which is by two Magnetical Poles and an Axis, inclin'd to the Axis of the Earth ; from whence it would follow that under the same Meridian, the Variation should be in all Places the same way.

These things being premised, may serve as a sure Foundation for this Theory, 'That the whole Globe of the Earth is one great Magnet, having 4 Magnetical Poles, or Points of Attraction, near each Pole of the Equator 2 ; and that in those Parts of the World which lie near adjacent to any one of those Magnetical Poles, the Needle is governed thereby ; the nearest Pole being always predominant over the more remote. The parts of the Earth wherein these Magnetical Poles lie, cannot as yet be exactly determined for want of sufficient *Data* to proceed geometrically : But as near as Conjecture can reach, I reckon that the Pole which is at present nearest to us, lies in or near the Meridian of the *Land's-End of England*, and not above 7 deg. from the Pole Artick. By this Pole the Variations in all *Europe* and *Tartary*, and the *North-Sea*, are principally governed, yet with regard to the other Northern Pole, whose Situation is in a Meridian passing about the middle of *California*, and about 15 deg. from the North Pole of the World. To this the Needle has chiefly respect in all the *North-America*, and in the two Oceans on either side thereof, from the *Azores* Westwards to *Japan*, and farther. The two Southern Poles are rather farther distant from the South Pole of the World : The one about 16 deg. therefrom, is in a Meridian some 20 deg. to the Westward of *Magellan's Streights*, or 95 deg. West from *London* ; this commands the Needle in all the *South-America*, in the *Pacifick Sea*, and the greatest part of the *Ethiopick Ocean*. The 4th and last Pole seems to have the greatest Power and largest Dominions of all, as it is the most remote from the Pole of the World, being little less than 20 deg. distant therefrom, in the Meridian which passes thro *Hollandia Nova*, and the Island of *Celebes*, about 120 deg. East from *London*. This Pole is predominant in the South part of *Africa*, in *Arabia*, and the *Red-Sea*, in *Persia*, *India*, and its Islands, and all over the *Indian Sea* from the Cape of *Good-Hope* Eastwards to the middle of the great *South-Sea* that divides *Asia* from *America*. This seems to be the present Disposition of the Magnetical Virtue throughout the whole Globe of the Earth.

By this Hypothesis it is plain that (our *European* North Pole being in the Meridian of the *Land's End of England*) all Places more Easterly than that will have it on the West-side of the Meridian ; and consequently the Needle respecting it with its Northern Point, will have a Westerly Variation, which will still be greater as you go to the Eastwards, till you come to some Meridian of *Russia*, where 'twill be greatest, and from thence decrease again. Thus at *Brest* the Variation is but $1\frac{1}{2}$ deg. at *London* $4\frac{1}{2}$ deg. but at *Dantzick* 7 deg. West. To the Westward of the Meridian of the *Land's End*, the Needle ought to

to have an Easterly Variation, were it not that (by approaching the *American* Northern Pole, which lies on the West side of the Meridian, and seems to be of greater Force than this other) the Needle is drawn thereby Westwards, so as to counterbalance the Direction given by the *European* Pole, and to make a small West Variation in the Meridian of the *Land's-End* it self. Yet I suppose that about the Meridian of the Isle *Tercera*, our nearest Pole may so far prevail as to give the Needle a little turn to the East, tho but for a very small space, the Counterbalance of those two Poles permitting no considerable Variation in all the Eastern Parts of the *Atlantick Ocean*, nor upon the West Coasts of *England* and *Ireland*, *France*, *Spain* and *Barbary*. But to the Westwards of the *Azores*, the Power of the *American* Pole overcoming that of the *European*, the Needle has chiefly respect thereto; and turns still more and more towards it as you approach it. Whence it comes to pass, that on the Coast of *Virginia*, *New-Engl.* *Newfoundland*, and in *Hudson's Streights*, the Variation is Westwards; that it decreases as you go from thence towards *Europe*; and that it is less in *Virginia* and *New-England* than in *Newfoundland*, and *Hudson's Streights*. This Westerly Variation again decreases, as you pass over the *North America*; and about the Meridian of the middle of *California*, the Needle again points due North; and from thence Westwards to *Yedzo*, and *Japan*, I make no doubt but the Variation is Easterly; and half Sea over not less than 15 deg. This East Variation extends over *Japan*, *Yedzo*, *Tartary*, and part of *China*, till it meet with the Westerly, which is govern'd by the *European* North Pole, and which I said was greatest somewhere in *Russia*.

Towards the Southern Pole the effect is much the same, only that here the South Point of the Needle is attracted. Hence it will follow, that the Variation on the Coast of *Brazil*, at the *River of Plata*, and so on to the *Streights* of *Magellan*, should be Easterly, as in the 3d Remark. And this Easterly Variation doth extend Eastward, over the greatest part of the *Ethiopick Sea*, till it be counterpoised by the Virtue of the Southern Pole; as it is about midway between the Cape of *Good Hope*, and the Isles of *Tristan d'Alcunba*. From thence Eastwards, the *Asian* South Pole (as I must take the liberty to call it) becoming prevalent, and the South Point of the Needle being attracted thereby, there arises a West Variation very great in quantity and extent, because of the great distance of this magnetical Pole from the Pole of the World. Hence it is, that in all the *Indian Sea* as far as *Hollandia nova*, and farther, there is constantly West Variation: And that under the *Equator* it self, it arises to no less than 18 deg. where 'tis most. About the Meridian of the Island *Celebes*, being likewise that of this Pole, this Westerly Variation ceases, and an Easterly begins; which reaches, according to my Hypothesis, to the middle of the South Sea between *Zelandia nova* and *Chili*, leaving room for a small West Variation govern'd by the *American* South Pole; which I shewed to be in the *Pacifick Sea*, in the 6th and 7th Remarks.

In the *Torrid Zone*, and particularly under the *Equinoctial*, respect must be had to all 4 Poles, and their Positions well considered; otherwise it will not be easy to determine what the Variations shall be, the nearest Pole being always the strongest: yet not so, as not to be counterbalanced sometimes by

by the united Forces of two more remote. A notable Instance hereof is in our 8th Remark, where I took notice, that in sailing from *St. Helena*, by the *Isle of Ascension*, to the *Equator* on a N. W. Course, the Variation is very little Easterly, and in that whole Tract unalterable : For which I give this Reason, that the *South American Pole* (which is considerably the nearest in the aforesaid Places) requiring a great Easterly Variation, is counterpoised by the contrary Attraction of the *North American* and the *Asian South Poles* ; each whereof singly is, in these Parts, weaker than the *American South Pole* : and upon the N. W. Course, the distance from this latter is very little varied ; and as you recede from the *Asian South Pole*, the Balance is still preserved by the Access towards the *North American Pole*. I mention not in this Case the *European North Pole*, its Meridian being little removed from those of these Places, and of it self requiring the same Variations we here find.

What I have here said does plainly shew the sufficiency of this Hypothe- n. 195. p. 564.
sis solving the Variations that are at this time observed.

But there are two Difficulties not easy to surmount. The one is, that no Magnet I have ever seen or heard of, hath more than two opposite Poles : Whereas the Earth hath visibly 4, and perhaps more. Secondly, It is plain by the change of the Variation, not only at *London*, where this Discovery was first made, but also almost all over the Earth, that these Poles are not, at least all of them, fixt in the Earth, but shift from Place to Place, whereas it is not known that the Poles of the Loadstone ever shifted their Place in the Stone, nor, considering the compact Hardness of that Substance, can it easily be supposed. These Difficulties for a long time made me despond, when in accidental Discourse, and least expecting it, I stumbled on the following Hypothesis.

It is sufficiently known and allow'd, that the Needle's Variation changes ; and that this Change is gradual and universal, will appear by the following Examples.

At *London*, *An. 1580.* The Variation was observed by *Mr. Burrows*, to be 11 deg. 15 min. East. In *An. 1622*, the same was found by *Mr. Gunter*, to be but 6 deg. East. In the Year 1634, *Mr. Gellibrand* found it 4 deg. 5 min. East. In 1657, *Mr. Bond* observed that there was no Variation at *London*. *An. 1672.* my self observed it 2 deg. 30 min. to the West ; and this present Year 1692. I again found it 6 deg. West. So that in 112 Years the Direction of the Needle has changed no less than 17 Degrees.

At *Paris*, *Oromius Finæus* about the Year 1550, did account it about 8 or 9 deg. East Variation. *An. 1640.* it was found 3 deg. East. *An. 1666.* there was no Variation there, and *An. 1681.* I found it to be 2 deg. 3 min. to the West.

At *Cape d'Agulhas*, the most Southerly Promontory of *Africa*, about the Year 1600. the Needle pointed due North and South without Variation, whence the *Portuguese* gave its Name. *An. 1622.* there was 2 deg. West Variation. *An. 1675.* it was 8 deg. West : and this Year 1692, it was curiously observed not less than 11 deg. West

At *St. Helena*, about the Year 1600. the Needle declin'd 8 deg. to the East. *An. 1623.* It was but 6 deg. East. *An. 1677.* when I was there, I
observed

observed it accurately on Shore to be 40 *min.* East ; and now this Year it was found 1 *deg.* to the Westward of the North.

At Cape Comorin in *India*, in the Year 1620, there was 14 *deg.* 20 *min.* West Variation ; in the Year 1680 there was 8 *deg.* 48 *min.* but in the Year 1688 it was no more than 7 *deg.* 30 *min.* so that here the Needle has return'd to the East, about 7 *deg.* in 70 Years.

From these, and many other Observations, it is evident that the Direction of the Needle is in no Place fixt and constant, tho in some it changes faster than in others. And where for a long time it has continued as it were unalter'd, it is there to be understood, that the Needle has its greatest Deflection, and is become Stationary, in order to return, like the Sun in the *Tropick*. This at present is in the *Indian Sea*, about the Island *Mauritius*, where is the highest West Variation, and in a Tract tending from thence into the N. N. W. towards the *Red Sea* and *Egypt*. And in all Places to the Westward of this Tract, all over *Africa* and the Seas adjoining, the West Variation will be found to have encreased ; to the Eastwards thereof, as in the Example of Cape Comorin, to have decreased, viz. all over the *East-Indies*, and the Islands near it.

After the like manner, in that space of East Variation, which, beginning near *St. Helena*, is found all over the *South America*, and which at present is highest about the Mouth of *Rio de la Plata*, it has been observed, that in the Eastern Parts thereof the Variation of the Needle gradually decreases. And by Analogy we may infer, tho we have not Experience enough to ascertain it, that both the East and West Variation in the *Pacifick Sea*, do gradually increase and decrease after the same Rule.

These *Phænomena* being well understood, and duly consider'd, do sufficiently evince, that the whole Magnetical System is by one, or perhaps more Motions translated : That this moving thing is very great, as extending its Effects from Pole to Pole ; and that the Motion thereof is not *per saltum*, but by a gradual and regular Motion.

Now considering the Structure of our terraqueous Globe, the only way to render this Motion intelligible and possible, is, to suppose it possible to turn about the Center of the Globe, having its Center of Gravity fixt and immoveable in the same common Center of the Earth : And there is yet required, that this moving internal Substance be loose, and detached from the external Parts of the Earth whereon we live. So then the external Parts of the Globe may well be reckoned as the Shell, and the internal as a *Nucleus* or inner Globe included within ours, with a fluid Medium between. Which having the same common Center and Axis of diurnal Rotation, may turn about with our Earth each 24 Hours ; only this outer Sphere having its turbinating Motion, some small matter either swifter or slower than the internal Ball, and a very minute difference in length of time, by many Repetitions becoming sensible, the internal Parts, will, by degrees, recede from the external, and not keeping pace with one another, will appear gradually to move either Eastwards or Westwards by the difference of their Motions. So that if this exterior Shell of Earth be a Magnet, having its Poles at a distance from the Poles

Poles of Diurnal Rotation ; and if the internal *Nucleus* be likewise a Magnet, having its Poles in two other Places distant also from the Axis, and these latter by a gradual and slow Motion change their place in respect of the external, we may then give a reasonable Account of the four Magnetical Poles, as likewise of the changes of the Needle's Variations, which, till now, hath been unattempted.

The Period of this Motion being wonderful great, and there being hardly an hundred Years since these Variations have been duly observed, it will be very hard to bring this Hypothesis to a Calculus, especially since, tho the Variations do increase and decrease regularly in the same place, yet in differing Places, at no great distance, there are found such casual Changes thereof, as can no ways be accounted for by a regular Hypothesis; as depending upon the unequal and irregular Distribution of the Magnetical Matter within the substance of the external Shell or Coat of the Earth: which defect, the Needle from the Position, it would acquire from the effect of the general Magnetism of the whole. Of this the Variations at *London* and *Paris* gave a notable Instance: For the Needle has been constantly about $1^{\circ}\frac{1}{2}$ more Easterly at *Paris* than at *London*, tho it be certain, according to the general Effect, the difference ought to be the contrary way. Notwithstanding which the Variations in both places do change alike. Hence, and from some other of like nature, I conclude, That the two Poles of the external Globe are fixt in the Earth, and that if the Needle were wholly govern'd by them, the Variations thereof would be always the same, with some little Irregularities upon the account I but just now mentioned: But the internal Sphere having such a gradual Translation of its Poles, does influence the Needle, and direct it variously, according to the result of the Attractive or Directive Power of each Pole; and consequently there must be a Period of the Revolution of this internal Ball, after which the Variations will return again as before.

If then two of the Poles be fixt, and two moveable, I think we may determine that the *European* Pole is that which is moveable of the two Northern Poles, and that that has chiefly influenced the Variations in these Parts of the World: For in *Hudson's Bay*, which is under the Direction of the *American* Pole, the change is not observed to be near so fast as in these parts of *Europe*, tho the Pole be much farther removed from the Axis: And that the *Asian*, of the two South Poles, is fixt, and consequently the *American* moveable; from the like Observation of the slow Decrease of the variation on the Coast of *Java*, and near the Meridian of the *Asian* Pole.

If this be allowed me, 'tis plain that this Motion is Westwards, and by consequence that the aforesaid *Nucleus* has not precisely attained the same Degree of Velocity with the exterior parts in their Diurnal Revolution: But so very nearly equals it, that in 365 Revolves the difference is scarce sensible. This I conceive to arise from the Impulse, whereby this Diurnal Motion was impress'd on the Earth, being given to the external Parts, and from thence in Time communicated to the internal.

The Period of this Motion appears, by all Circumstances, to be of many Centuries of Years; and considering the change of the Place, where there was no Variation, by reason of the *Æquilibrium* of the two Southern magnetical Poles, viz. from Cape d' *Agulhas* to the Meridian of St. *Helena*, (which is about 23° . in about 90 Years) and of the place where the Westerly Variation is in its *acutest* or greatest Deflection, being about half so much, viz. from the Isle of *Diego Roiz* to the South-West Parts of *Madagascar*; we may with some reason conjecture, that the *American Pole* was moved Westwards 46° in that time; and that the whole Period thereof is performed in seven hundred Years, or thereabouts: So that the nice determination of this, and of several other particulars in the Magnetick System, is reserved for remote Posterity.

I doubt not but this Hypothesis of an Internal *Nucleus* will find Opposers enough: But the Globe of *Saturn* being environ'd with his Ring, is a notable Instance of this kind, as having the same common Center, and moving along with it, without sensibly approaching one side of it more than another: And if this Ring were turned on one of its Diameters, it would then describe such a Concave Sphere as I suppose our External one to be. And since the Ring in any position given, would in the same manner keep the Center of *Saturn* in its own, it follows that such a Concave Sphere may move with another included in it, having the same common Center. Nor can it well be supposed otherwise, considering the nature of Gravity: For should these Globes be adjusted once to the same common Center, the gravity of the parts of the Concave would press equally towards the Center of the internal Ball, which Equality must necessarily continue till some external Force disturb it; which is not easy to imagine in our Case. This perhaps I might more intelligibly express, by saying, That the inner Globe being posited in the Center of the exterior, must necessarily ascend, whatsoever way it move; that is, it must overcome the force of Gravity pressing towards the common Center, by an Impulse it must receive from some outward Agent: But all outward Efforts being sufficiently fenced against, by the Shell that surrounds it, it follows, that this *Nucleus* being once fixt in the common Center, must always there remain.

It may be objected, that the Water of the Sea would perpetually leak thro this Shell, unless we suppose the Cavity full of Water: But when we consider how tightly great Beds of Chalk or Clay, and much more Stone, do hold Water, and even Caves arched with Sand, no Man can doubt but the Wisdom of the Creator has provided for the *Macrocosm*, by many other Ways than I can either imagine or express. We cannot think it a hard supposition that the internal Parts of this Bubble of Earth should be replete with such Saline and Vitriolick Particles as may contribute to Petrefaction, and dispose the transuding Water to shoot and coagulate into Stone, so as continually to fortify, and, if need were, to consolidate any breach or flaw in the Concave Surface of the Shell. And this perhaps may, not without Reason, be supposed to be the final Cause of the Ad-
mixture

mixture of the magnetical Matter in the Mass of the terrestrial parts of our Globe, viz. To make good and maintain the Concave Arch of this Shell: For by what the excellent Mr. Newton has shewn, in his *Principia Philosophia*, it will follow, That according to the general Principle of Gravity, visible throughout the whole Universe, all those Particles that by length of time, or otherwise, shall moulder away, or become loose on the Concave Surface of the external Sphere, would fall in, and with great force descend on the internal, unless those Particles were of another sort of Matter capable, by their stronger tendency to each other, to suspend the force of Gravity: but we know no other Substances capable of supporting each other by their mutual Attraction, but the Magnetical; and these we see miraculously to perform that Office, even where the power of Gravity has its full Effect, much more within the Globe where it is weaker. Why then may we not suppose these said Arches to be lined throughout with a Magnetical Matter, or rather to be one great Concave Magnet, whose two Poles are the Poles we have before observed to be fixt in the surface of our Globe?

Another Argument favouring this Hypothesis, is drawn from a Proposition of the same Mr. Newton, where he determines the force wherewith the Moon moves the Sea in producing the Tides: His Words are, *Densitas Lunæ est ad Densitatem Terræ ut 680 ad 387. seu 9 ad 5. quam proxime. Est igitur Corpus Lunæ densius, ac magis terrestre quam Terra nostra.* Now if the Moon be more solid than the Earth as 9 to 5, why may not we reasonably suppose, the Moon being a small Body, and a secondary Planet, to be solid Earth, Water and Stone, and this Globe to consist of the same Materials, only 4 Nincths thereof to be Cavity, within and between the internal Spheres, which I would render not improbable?

It must be allowed indeed, that these included Globes can be of very little service to the Inhabitants of this outward World, nor can the Sun be serviceable to them either with his Light or Heat: But since we see all the parts of the Creation abound with animate Beings, why should we think it strange that the prodigious Mass of Matter, whereof this Globe does consist, should be capable of some other Improvements, than barely to serve to support its Surface? Why may we not rather suppose that the exceeding small quantity of solid Matter in respect to the fluid Æther, is so disposed by the Almighty Wisdom, as to yield as great a Surface for the use of Living Creatures, as can consist with the Conveniency and Security of the whole?

And tho without Light there can be no Living, yet there are many ways of producing Light which we are wholly ignorant of: The Medium it self may be always luminous after the manner of our *Ignes fatui*; the Concave Arches may in several places shine with such a Substance as invests the Surface of the Sun; nor can we without a Boldness unbecoming a Philosopher, adventure to assert the Impossibility of peculiar Luminaries below, of which we have no sort of Idea.

Thus I have shewed a Possibility of a much more ample Creation, than has hitherto been imagin'd: A Notion till hitherto not so much as started in the World, and of which we could have no Intimation from any other of the *Phænomena* of Nature.

But there may be a farther use of this Cavity of the Earth; viz. to diminish the specifick Gravity thereof in respect of the Moon: for I think I can demonstrate that the Opposition of the *Æther* to the Motions of the Planets in long time becomes sensible, and consequently the greater Body must receive a less Opposition than the smaller, unless the specifick Gravity of the smaller do proportionably exceed that of the greater, in which Case only they can move together. So that the Cavity I assign in the Earth, may well serve to adjust its Weight to that of the Moon: For otherwise the Earth would leave the Moon behind it, and she become another Primary Planet.

An Invariable Compass; By M. de la Hire, n. 188. P. 344.

IX. 1. Having determined as well as I could the South Pole of a *Terella* or spherical Loadstone, of 3 Inches Diameter, which accidentally had fallen into my Hands, I was much surprized to find it 18° distant from a Cross, deep engraven on the Stone, which according to all appearance had heretofore been the Pole of this Stone, as it had been observed by him that cut it. This Change having revived some Thoughts I had formerly entertained concerning the Variation of the Needle, I believed that if it were true that the Poles of the magnetical Virtue changed in the Loadstone, as we see they change in the Earth, one might derive great Advantages therefrom: For if this Change of these Poles in the Loadstone were certain, and that it was analogous to the Change of the Poles of the magnetick Virtue in the Earth, it is not to be doubted but a *Terella*, being suspended at liberty, would remain immoveable, and that one Point thereof would regard the Pole of the World, which might be called the true Pole of the Stone, whilst the Poles of its Virtue would pass successively from one part to another, after the same manner as they change in the Earth.

After having well considered this Hypothesis, and having cleared up some doubts which I had, concerning the Position of the Stone at the time when its Pole had formerly been determined, I concluded that this former Pole was distant from the Point I call the true Pole, 13 Degrees towards the East, in the Place where it had been marked, (and which is unknown to me) since that at this time in this Country the Needle varies about 5 deg. Westward.

Upon this Hypothesis, which I know not that any one else has yet thought upon, I have invented a new sort of Needle for the Compass, which may have the same Alterations as a spherical Loadstone, and at the same time the same Conveniencies as the ordinary Needle hath.

I caused a Ring of 3 Inches Diameter to be made of Steel-Wire; from which there went 3 Radii of very fine Brass-Wire meeting at the Center in

a Cup perfectly like that of an ordinary Compass, that so this Circle might rest on a Pin in its Center, and be at full Liberty to turn round, its Center being fix'd. This done, I gave the magnetical Touch to this Steel Ring, by applying indifferently to a Point thereof, one of the Poles of a strong Loadstone, and the other Pole of the Stone to the opposite Point, to give the greater Virtue to the Ring. Then I observed that the Ring was strongly magnetical, and that the Point called the South Pole did readily turn it self towards the North, and after several Vibrations stopped there, and that it had also the same Inclination towards the Pole, which is found in Needles after they have been touched: Lastly, I fixed upon the Ring a small *Fleur de Lis* of Brass in the Point, which exactly respected the North, the Ring being first well settled.

To inform my self, if a Steel Ring had the same Effects as a *Terella*, I made the following Experiment. Having touched a Steel Ring, and having laid it on a Paper, I strewed the Filings of Steel upon it; and then gently shaking the Paper, I saw that the Direction of the magnetical Matter passed directly cross the Ring from one Pole to the other, and that there were two Vortices on the sides, as it is observed in the spherical Magnet, which seems very surprizing: for according to the ordinary Hypothesis of the Magnet, the magnetical Virtue passing more easily in the Steel than in the Air, should run on both sides of the Pole round the Ring, and only form a Pole opposite to the first. But I was further confirmed in this Opinion, by applying a flat and pointed Piece of Iron like the Blade of a Knife, to a Loadstone, so as the Point of the Iron reached beyond the Stone; and having afterwards presented this Point to the magnetical Ring, I observed that different Points of the Ring did apply to the Point of the Iron, according as the several Points thereof had been applied to the Stone; which happens not in the magnetical Needle, for that always presents one of its Ends to the Point of the Iron, being not disposed, by reason of its Length, to receive the magnetical Matter in all the Parts thereof analogous to those of the Stone. It must only be noted, that in an irregular Stone, the magnetical Virtue appears stronger towards the Angles than in the other Parts; which may cause some Irregularity in this Experiment, if it be tried with a Stone that is very uneven.

Those Experiments gave me the Curiosity of making another, by touching two Semicircles of Steel. Having joined the two Ends, touched by the same Poles, I observed by the Steel-Dust the same Effect as in the Ring; but having joined the Ends differently touched, I found that immediately the two half Rings run together, and stuck to each other; and by the Steel-Dust strowed on Paper, I observed, that there were 4 Vortices, one in the middle of each Semicircle, and one at each of the Places where they were joined, and that the 2 latter were less than the others, and much stronger. I saw likewise, that there were 4 Poles, each of which was within a Vortex, and that each retained in its Semicircle the Virtue of the Ends of the half Rings.

I tried, after having touched a Steel Wire that was straight, to make a Ring thereof. But I found that it had quite lost its Virtue, which cannot be

be attributed to the Junction of the Poles, since they ought to stick together, according to the other Experiments which have been made, but only to this, that it hath been already noted, that when a magnetical *Virgula* is a little bent, it loses its Virtue, which cannot happen, but from the Alteration of the Pores of the Steel.

I farther remarked, that a Ring of Steel having been touched, does for a long time retain its Virtue, although it be put in a Position contrary to its Poles. And this Experiment is confirmed by another much more considerable, which is, that a Ring of Steel having been touched with a strong Loadstone, cannot without difficulty receive a contrary Touch from a Magnet, less strong than the first: But that in time, by little and little, it resumes its former Virtue; much as we see Magnets do, which being applied to another Stone, by the Poles of the same Denomination, lose their first Virtue and take a contrary, which they afterwards lose by degrees, to reassume their first.

After I had presented this new System of the Magnet to the Academy, there were made some Experiments upon a *Terella* of much the same Diameter with mine, but whose Poles were not diametrically opposite; and upon a half Globe, very much bigger than the *Terella*: But we could find in them no considerable Difference, or Alteration of Poles. Because of some Circumstances, the Company thought fit that some Experiments should be made with this Sort of Compass.

These circular Needles may be touch'd anew after this manner; Apply the Poles of the Stone to the Ring, and the Ring which is suspended upon its Pivot, will turn so as the Point answering to the Pole of the Virtue of the Stone which is applied to it, will come as near to it as possible: Insomuch, that without touching the one or the other, the Ring will not fail to receive very much Force. The same may be done at the opposite Point.

The Principles examined, ib. p. 250.

2. This Account having been read before the Royal Society, it was ordered, that the *Terella* which has been in their Repository these 25 Years, should be examined; and it was found, that the Points which are marked thereon with Crosses were, as near as could be discerned, the true Poles of the Stone, notwithstanding that the Variation has changed at London full 4 deg. since the *Terella* has been in the Society's Custody, and perhaps many more since it was marked; and had there been a Change in the Poles of the Loadstone analogous thereto, it must needs have been perceived in this, whose Diameter is about $4\frac{1}{2}$ Inches. However, to put this Matter past Dispute, Care was taken to find out exactly and mark the Poles of the Society's great Loadstone, the Sphere of whose Activity is above nine Foot Radius, and whose Poles are 13 Inches asunder; whereby if this Translation of the Poles be real, it cannot fail of being made very sensible hereafter. In the mean time, some of the Company well skill'd in Magneticks, were of Opinion, that such a circular Needle would librate on its Center, so as to respect the magnetical Meridian with the Points that had at first received the Touch, rather than that the Ring remaining immoveable, the directive Virtue should be transferred

therein from Place to Place, either by length of time, or by transporting this Compass into those Parts, where the Variation of the Needle is considerably different.

An Account of a Book, Omitted.

Epistola invitatoria, ad Observationes Magneticæ Variationis, communis n. 143. p. 3
Studio junctisque Laboribus instituendas, *Altorf* 1682.

CHAP. V.

Botany. Agriculture.

I. **P**repare two Plates of Iron as large as you desire to preserve the Specimens. These Plates must be too thick to bend, very smooth on one side, and Holes for Screws on each Corner, to screw them close. Then take your Flowers, Leaves, &c. when perfectly ripe, and in their true Colours, spread them on a Brown-Paper, with the Leaves as distinct as you can; and if the Flowers be large, there must more Paper lie under it, and if it be thick, you may pare away the one half thereof, as also of the Stalk, so as to make it lie almost flat: and some distinct Leaves may be separated and taken out, as a By-store, to be afterwards stuck in, and compleat the Flower. Then lay over all more Brown-Paper, and put these between the Iron Places, screw 'em close, put the same into an Oven for two Hours, just as the Bread is drawn; after which, take out the Flowers; then take *Aqua Fortis* and *Aqua Vita*, or Brandy in equal Quantity, mixed together, and with a Brush pass over the Leaves of the Flowers. Then lay them on fresh Brown-Paper, and press them a little with a Handkerchief, or with your Fingers, to grow dry. Then take the Bigness of a Walnut of Gum-Dragon, which in less than 24 Hours will be dissolved in a Pint of fair Water; and with a fine Brush, rub the Backsides of your Flowers and Leaves, to make them stick; and then lay them into your Paper-Book, where they will lie fast, and always look fresh.

There must be a little Skill after the Oven, to turn the Leaves into Shape; and a sort of Perspective, in case the Flower be too thick: and if you would add any Smell to these Flowers, which will have none, touch them with such Essence as you think fit.

II. 1. As I passed thro *Marton Woods*, under *Pinno moor* in *Craven*, Aug. 18, 1672, I found an infinite Number of Mushrooms, some withered, and others new sprung and flourishing. They were of a large Size, something bigger than the ordinary red Gilled eatable Mushroom, or Champignon, and very much of their Shape, that is, with a perfectly round Cap, or Stool, as we vulgarly call it, thick in Flesh, and with open Gills underneath, having a thick, fleshy not hollow, and round Foot Stalk, of about 6 Fingers.

To preserve the Specimens of Plants, by Sir Robert Southwell, n. 137. p. 44.

An odd kind of Mushroom, by Dr. Lister, n. 89. p. 116.

gers Breadth high above Ground, and ordinarily as thick as my Thumb. If you cut any part of this Mushroom, it will bleed exceeding freely a Milk white Juice, which tastes much hotter upon the Tongue than Pepper; it is not clammy to the Touch, and the Air does not much discolour it, or the Blade of a Knife, as is usual with most vegetable Juices. It became in the Glass Vial I drew it into suddenly concrete and stiff, and did in some Days dry into a firm Cake; which also when well dried, retained its fierce biting Taste and white Colour.

Further, I observed these Mushrooms full of Juice, not to be endured upon our Tongues, to abound with Fly Maggots. Also the youngest and tenderest of them, that is, such as are most juicy, to have been very much eaten by the grey Meadow-naked Snail, lodging themselves within the side of the Plant.

By Mr.
Wray, ib:
P. 5117.

2. I doubt not but this Mushroom is that described in *Joh. Bauhin, l. 40. c. 6.* under the Title of *Fungus piperatus albus, lacteo succo turgens.* For in almost all Points the Descriptions agree exactly.

Another
sort of
Mushrooms,
by Dr. Lister,
n. 110.
P. 225.

3. The *Fungus porosus crassus magnus* J. B. when fresh gathered, is of a Buff-Colour, inside and outside; and yet cut thro the Middle, it will in a Moment change from a pale Yellow to a deep Purple or Blue, and stain Linen accordingly. A Drop of the Juice leisurely squeezed out, will change, holding it betwixt your Eye and the Light, thro all the Colours of the Rainbow, in the very time of its falling, and fix in a Purple, as it doth in the springing out of its Veins.

The Flowers
and Seed of
Mushrooms,
by Dr. Lister,
n. 110.
P. 225.

III. I am of opinion, that Mushrooms are Plants of their own kind, and have more than a chance Original. We will instance in that species call'd *Fungus porosus crassus magnus* J. B. The Texture of the Gills is like a Paper prick'd full of Pin-holes. In August this is very frequent under Hedges, and in the middle of the Moors in many Places of *Yorkshire*. It seems to me, (and no doubt, it will to any Person that shall well examine it) that the Gills of this Mushroom are the very Flower and Seed of this Plant. When it is ripe, the Gills here are easily separable from the rest of the Head: Each Seed is distinct from other, and hath its Impression in the Head of the Mushroom, just as the Seeds of an Artichoke hath in the Bottom of it. The bigger End of the Seed is full and round, and they are disposed in a spiral Order, just as those of the Artichoke. The like we do think of all other Mushrooms, however differently figured.

And if it shall happen to him that shall sow them, that these will not produce their Kind, but be sterile, it is no strange thing amongst Plants, there being whole Genus's of Plants that come up, and flower and feed, yet their Seed was never known to produce Plants of their Kind; being naturally sterile, and a volatile Dust, as all the *Orchides* or Bee-Flowers.

Truffles, by
Dr. Tanc.
Robinson, n.
202. p. 814,
824. n. 204.
P. 935.

IV. The *Tubera Terræ* observed lately at *Rushton* in *Northamptonshire*, by Dr. Hatten of *Harborough* in *Leicestershire*, are the true *French Truffles*, the *Italian Tarruffs*

Tartuffi or *Tartuffole*, and the *Spanish Turmas de Tierra*, which are not noted by Mr. Ray, to be found in our *British Soil*. I have seen 'em thrice as large at *Florence, Rome, and Naples*, where they eat them as a delicious and luxurious Piece of Dainty, either fried in Slices with Butter or Oyl, Salt and Pepper, or else out of Pickle, and often boiled in their Soup. These observed in *England* are all included in a studded Bark or Coat, the *Tubercules* resembling the *Fig. 157.* *Capsules*, or Seed Vessels, of some *Mallows* and *Alcea's*. The inward Substance *Fig. 158.* is of the Consistence of the fleshy Part in a young Chestnut, of a Paste Colour, of a rank or hircine Odour, and unsavoury, streaked with many white Veins or Threads, as in some Animals Testicles. The whole is of a globose Figure, tho unequal and chinky; they are most tender in the Spring, tho after Showers and sultry Weather, they may be plentifully found in the Autumn. The Wet swells them, and Lightning and Thunder may dispose them to send forth their particular Scent so alluring to the Swine, for some of the Antients call'd them *Ceraunia*.

Dr. Hatton observed Fibres issuing out of some of these *Tubera*, which lay *Fig. 157.* Spit-deep under Ground, so that perhaps they may be *Plantæ sui generis*, and their sulcated *Papillæ* analogous to, if not Seed Vessels; you know several Vegetables bear their Seed near the Root, as the *Trifolium subterraneum triccocum, reticulatum Flosculis longis albis*, most of the *Arachidna's*, and some other Legumes, which flower above, but seed under Ground. As to the Truffles lying so deep, that is common to many Roots that shoot up Stalks above the Earth. To instance only in that *Lathyrus tuberosus*, call'd commonly *Chama-balanus* and *Terra Glandes*, in *English* Pease Earthnuts, digg'd up and eaten by the poor People, *non nisi alta Fossione inveniendæ*, says *John Bauhine*. The Roots of our *Bulbocastanum* (of the umbelliferous Tribe) commonly call'd Kepper-nuts, Pignuts, and Gernuts, in the North, lie very deep, and fatten Hogs, which are very greedy of them.

V. Some Years since M. *Perrault* related to the Royal Academy at *Paris*, that travelling thro *Sologne*, he had been inform'd by some Physicians and Chirurgeons of that Country, that the Rye there was sometimes so corrupted, that those who did eat of the Bread which had much of this corrupted Grain in it, were seiz'd on by a Gangrene. We have view'd some of these Grains of Rye thus degenerated, they are black without, and pretty white within, and when they are dry they are harder and closer than the natural good Grain. They have no ill Taste. I have found some of them that had hanging at their Basis a Substance of a Honey-Taste and Consistence. They become much longer in the Ear than the other. There are some of them that are 13 or 14 Lines long, and 2 Lines large, and at times you will find 7 or 8 of them in one Ear. It may be seen in examining these Ears, that they are not Bodies of another kind, generated among the Grain of Rye, as some pretend; but that they are true Grains of Rye, having their Coats like the rest, wherein may be distinguished the Place of the Germen, and of the Furrow.

There happened many like Accidents in 1674, at *Montargis* from the same Cause. M. *Dodart* caused to be brought to him some Ears of this Rye, and

and the Company found the Grains of them altogether like those they had seen formerly.

M. *Tuillier* hath imparted a Letter of M. *Chatton*, an old and expert Chyrurgeon at *Montgarvis*, whence he saith he hath learned the Particulars following, viz. Rye doth in this manner degenerate in *Sologne*, *Berry*, the Country of *Blaise* and *Gastinois*, and almost every where, especially in light and sandy Land. There are few Years but some little of this ill Grain grows. When there is but little, the ill Effects of it are not perceiv'd. It grows plenteously in wet Years, and most of all when after a rainy Spring there follows excessive Heats. The Constitution of the Air, or of the Rains, which impress this Malignity in the Rye, is rare, there having been found none at *Montgarvis* but thrice in 38 Years, and there having been but few Distempers of it the second time, because there was but little of that corrupted Grain. The Bread made of the Rye, which holds some of this corrupted Corn, tastes neither worse nor better than other. The Rye thus corrupted hath its Effects chiefly when 'tis new, yet not till it hath been used a considerable time.

These Effects are to dry up the Milk in Women, to cause sometimes malignant Fevers, accompany'd with Drowsiness and Raving, to breed the Gangrene in Arms, but most in Legs, which ordinarily are corrupted first, and to which this Distemper fastens it self, as the Scorbute doth. This Corruption is preceded by a certain Stupefaction in the Legs, upon which follows a little Pain, and some Swelling without Inflammation, and the Skin becomes cold and livid. The Gangrene begins at the Center of the Part, and appears not at the Skin till a long while after, so that People are often obliged to open the Skin, to find only the Gangrene lurking under it.

The only Remedy for this Gangrene is to cut off the Part affected: If it be not cut off, it becomes dry and lean, as if the Skin were glued over the Bones; and 'tis of a dreadful Blackness, without Rottenness.

Whilst the Legs are drying up, the Gangrene ascends to the Shoulders, and one knows not which way it communicates it self.

We have not as yet lighted upon a Specifick Remedy against this Evil. There is some hope of preventing it by hot Spirits and volatile Salts. The *Orvietan* and *Ptyisan* of *Lupins* do considerable good to the Person distemper'd. Poor People are almost only subject to these Evils.

M. *Tuillier* also writes word, that in 1675 he saw much of this corrupted Grain among the Rye of the Country of *Gastinois*; and that the Country People told him, that there was much more of it this Year 1676, than the last Year, and that it caused great Disorders: and yet 'tis certain that this Summer hath been rather cold than hot, and that there hath not been any considerably intemperate Weather this Year, but excess of Wet.

However, it may be doubted, whether these Gangrenes are the Effects of this Corn eaten, or whether the corruption of the Rye, and that of the parts in the Bodies of Men, are not Accidents equally derivable from the same Constitution of the Air, and independent the one from the other. Yet M. *Tuillier* has assur'd M. *Doddard*, that in the Year 1630, which was fatal to the Poor of the Countries subject to these Evils, he being at *Sully*, and having under-

understood by a Physician and Chirurgeon, that the cornuted Rye was the Cause of the *Gangrenes* that were then very frequent, being desirous to satisfy himself whether this Grain was indeed the Cause thereof, he gave of it to several Animals, which died of it.

VI. Malt is made in *Scotland* of no other Grain but Barley, whereof there are 2 kinds; one which hath 4 Rows of Grain on the Ear, the other 2 Rows. The first is the more commonly used, but the other makes the best Malt.

To make
Malt, By
Sir Robert
Murray. n.
142. p. 1069.

The more recently Barley hath been threshed, it makes the better Malt; but if it hath been thresh'd six Weeks, or upwards, it proves not good Malt, unless it be kept in one equal Temper; whereof it easily fails, especially if it be kept up against a Wall; for that which lies in the middle of the Heap is freshest; that which lies on the out-sides and at top is over-dry'd, that which is next the Wall shoots forth, and that which is at the bottom rots. So that some Grains do not come well (as they call it) that is, never get that right mellow Temper Malt ought to have, and so spoil all the rest: For thus some Grains come well, some not at all, some half, and some too much.

The best way to preserve threshed Barley long in good Temper, is not to separate the Chaff from it; but as long as it is unthreshed, it is always good. Brewers use to keep their Barley in large Rooms on boarded Floors, laid about a Foot in depth, and so turned over now and then with Scoops.

Barley that hath been over-heated in the Stacks or Barns, before it be separated from the Straw, will never prove good for Malt, nor any other Use. But tho it heat a little after it is threshed and kept in the Chaff, it will not be the worse, but rather the better for it, for then it will come the sooner, and more equally. A mixture of Barley that grows on several Grounds, never proves good Malt, because it comes not equally: So that the best Barley to make Malt of, is that which grows in one Field, and is kept and threshed together.

Take then good Barley newly threshed, and well purged from the Chaff, and put hereof eight Bolls, that is about six *English* Quarters, in a Stone Trough; where let it infuse till the Water be of a bright reddish Colour, which will be in about three Days, more or less, according to the Moistness or Dryness, Smallness or Bigness of the Grain, Season of the Year, or Temper of the Weather. In Summer Malt never makes well; in Winter it will need longer Infusion than in the Spring or Autumn.

It may be known when steep'd enough, by other Marks besides the Colour of the Water, as the excessive swelling of the Grain, or if over-steep'd, by too much Softness; being, when in the right Temper, like that Barley which is prepared to make Broth of.

When the Barley is sufficiently steeped, take it out of the Trough, and lay it on Heaps, so let the Water drain from it: Then, after two or three Hours, turn it over with a Scoop, and lay it in a new Heap about 20 or 24 Inches deep.

This Heap they call the coming Heap, and in the managing of this Heap aright lies the greatest Skill. In this Heap it will lie 40 Hours, more or less, according to the forementioned Qualities of the Grain, &c. before it come to the right temper of Malt; which that it may do equally, is most to be desired.

Whilst it lies in this Heap, it is to be carefully look'd to, after the first 15 or 16 Hours: For about that time the Grain will begin to put forth the Root, which when they have equally and fully done, the Malt must within an Hour after be turned over with a Scoop, otherwise the Grains will begin to put forth the Blade or Spire also, which by all means must be prevented; for hereby the Malt will be utterly spoil'd, both as to the pleasantness of Taste and Strength.

If all the Malt comes not equally, because that which lies in the middle being warmest, will usually come first, turn it over, so as the outmost may lie inmost, and so leave it till all become alike.

So soon as the Malt is sufficiently come, turn it over, and spread it to a depth not exceeding 5 or 6 Inches; and by that time it is all spread out, begin and turn it over and over again, three or four times. Afterwards, turn it over in like manner once in 4 or 5 Hours, making the Heap thicker by degrees, and continuing so to do constantly, for the space of 48 Hours at least. This frequent turning it over cools, dries, and deads the Grain, whereby it becomes mellow, melts easily in Brewing, and then separates entirely from the Husk.

Then throw up the Malt into a Heap, as high as you can; where let it lie till it grows as hot as your Hand can endure it, which usually comes to pass in some 30 Hours space. This perfects the sweetness and mellowness of the Malt.

After the Malt is sufficiently heated, throw it abroad to cool, and turn it over again about 6 or 8 Hours after, and then dry it upon a Kiln; where after one Fire, which must serve for 24 Hours, give it another more slow, and if need be, a third. For if the Malt be not thoroughly dry'd, it cannot be well ground, neither will it dissolve well in the Brewing, and the Ale it makes will be red, bitter, and will not keep.

The best Fewel is Beat, the next Charcoal, made of Pit-coal or Cinders. Heath-Broom and Furzes are naught. If there be not enough of one kind, burn the best first, for that gives the strongest Impression as to the Taste.

The Granaries in London, by Dr. Merrit.
n. 25. P. 464.

VII. 1. All the 12 Companies of *London*, and some other Companies, and private Persons, have their Granaries at the *Bridge-house* in *Southwark*: (where are a Justice of the Peace, a Steward, and two Masters.) These Granaries are built on two sides of an oblong Square; one whereof stands North and South, and is near 100 Yards long; whose Lettice-Windows respect North-East; the other side may be about 50 Yards long; the Windows look to the North, and the opposite sides have no Apertures. All the Windows are

are about a Yard high, without any Shutters, and run on in a continued Series, with very small Partitions, sufficient only to nail the Lettices to; each of them is 3 or 4 Stories high. The Ground or lowermost Story, 12 Foot from the Ground, is used only for a Ware-house, &c. To settle the first Story upon strong Pillars, fortify'd with Spikes of Iron, that no Vermin might get up, would make that Story fitter for drying of Corn, and more persflatile. In some Places they put, in all the Inside of their Rooms, Iron Wire of so narrow Meshes, that neither Rats nor Mice can get thro them, 2 or 3 Foot deep. Others erect, on all sides, Boards of Timber, and fasten others to the top of the perpendicular one, lying either parallel to the Horizon, or so that they make an acute Angle with the former, to the same purpose: For, besides the devouring of the Grain, the Excrements and Urine of that Vermin moistening the Wheat or Rye, make them apt to corrupt and breed Weevils.

The two main Considerables in building these Granaries, are, to make them strong, and to expose them to the most drying Winds.

The ordering of their Corn is this, in *Kent*, to separate the Dust and other Impurities in it, when 'tis thresh'd, they throw it in Shovels, from one side to the other, which the longer it is, the better; by which means all such Impurities remain in the middle, betwixt the two Heaps of Corn, which they skreen to part the Corn that is good, from the said Impurities. Then when they bring the Grain into the Granaries, they lay it about half a Foot thick, and turn it twice a Week, and once in that time skreen it; and this for 2 Months space. After that they lay it a Foot thick for 2 Months or more, turning it once or twice a Week, and skreen it proportionably, according as the drying Season is, seldomer or oftner. After 5 or 6 Months they raise it to 2 Foot in height, and turn it once a Fortnight, and skreen it once a Month, as occasion is. After a Year, they lay it two and a half, or 3 Foot deep, and turn it once in three Weeks, or a Month, and skreen it proportionably.

When it hath lain 2 Years or more, they turn it once in 2 Months, and skreen it once a Quarter, and so on, as they find it in Brightness, Hardness, and Dryness. The oftner these 2 things are done, the better the Grain proves. They leave an empty Space about a Yard wide on all sides of the Room, and at 6 Foot distance, thro the whole *Area*, empty of Corn; into which empty Places they turn the Corn as often as 'tis needful.

In *Kent* they make 2 square Holès in both the ends of the Floor, and one round in the middle: by which they throw the Corn from the upper into the lower Rooms, & *contra*, to air and dry it the better.

The Skreens are made with 2 Partitions, to separate the Dust from the Corn, which falls into a Bag; and when sufficiently full, is cast away, the good Corn remaining behind.

Corn has been kept in *London* Granaries 32 Years, and the longer 'tis kept the more Flower it yields, in proportion to the quantity of Corn, and makes the purer and whiter Bread; the superfluous Humidity only evaporating.

At Zurich;
By Dr. Pell,
ib.

2. Dr. Pell mention'd at a Meeting of the *Royal Society*, that they keep Corn at Zurich in *Helvetia* 80 Years.

In Dantzick
and Muscovy;
By---ib.
p. 466.

3. Observing Merchants and Travellers tell us, that the Granaries of *Dantzick* are generally 7 Stories high, and some 9 Stories; having each of them a Funnel, to let the Corn run down from one Floor to another, thereby chiefly saving the Labour and Charges of carrying it down. And then, that they in that Town are built altogether surrounded with Water, whereby the Ships have the Conveniency of lying close to them, to take in their Lading. No Houses are suffer'd to be built near them, to be thereby secured from the Casualties of Fire.

Those of *Muscovy* are made under-ground, by digging a deep Pit, of almost the Figure of a Sugar-Loaf, broad below, and narrow at the Top; the Sides well plaistered round about, and the Top very closely covered with Stone.

The People of that Country are so very careful, to have the Corn well dried, before they put it into those subterraneous Granaries, that when the Weather of that *Northern Climate* serves not to dry it sufficiently, they heat their Barns by the means of great Ovens; and thereby well drying their Corn, supply the Deficiency of their short Summer.

Turnep and
Potato
Bread; By
Dr. Beal, n.
90. p. 5142.

VIII. 1. In the Year 1629, and 1630, there was a Dearth in *England*; and much Talk they had then, that in *London* they had a way to knead and ferment boil'd Turneps with a small Quantity of Meal, and that it made better Bread for Whiteness, Pleasantness, Lasting and Wholsomness, than is made of the finest Flower or Wheat. Turneps, Rapes, Carrots, Parsneps, Potatoes, and other Roots, lie safe under Ground from scorching heat, and are said to thrive best in the greatest Rain. Potatoes were a Relief to *Ireland* in their last Famine. They yield Meat and Drink.

Turnep
Bread; By
Mr. Sam.
Dale, n. 205.
p. 970.

2. The Dearness of all sorts of Corn in 1693, occasion'd many poor People in *Essex* to make Bread of Turneps. The way of making it is this, they take pill'd Turneps, and boil them in Water until they are soft or tender; then pressing strongly out the Juice, they mix them with their Weight of Wheat-Meal; then adding Salt and Yeast, of each *q. s.* and warm Water, they knead it up as other Dough or Paste; which having lain a little while to ferment, they order and bake it as common Bread. This Turnep-Bread, to the Eye, is not to be distinguished from common Wheaten or Household Bread; neither doth the Scent much betray it, especially when cold; only to dainty and nice Palates, the Turneps are a little, and but a little perceived.

The Culture
of Maize; By
Mr. Win-
thorp. n.
142. p. 1065.

IX. The Corn used in *New-England* before the *English* planted there, is call'd by the Natives *Weachin*, and is known by the Name of *Maize* in some Southern Parts of *America*. The Ear is for the most part about a Span long, composed of several, commonly 8 Rows of Grain, or more, according to the Goodness of the Ground; and in each Row, usually above 30 Grains. It is of various Colours, as red, white, yellow, blue, olive, greenish, black,

black, speckled, striped, &c. sometimes in the same Field and the same Ear. But the white and yellow are the most common.

The Ear is clothed and armed with several strong thick Husks, not only defending it from the cold of the Night, (being the latter end of *September*, in some Parts, before it be full ripe) and from unseasonable Rains; but also from the Crows, Starlings, and other Birds; which being allur'd by the sweetness of the Corn before it hardeneth, come then in great Flights into the Fields, and pecking thro the top of the Cover, devour as far as they can reach.

The Stalk groweth to the height of 6 or 8 Feet, more or less, according to the condition of the Ground, or kind of Seed. The *Virginian* groweth taller than that of *New-England*: And there is another sort used by the Northern *Indians* far up in the Country, that groweth much shorter than that of *New-England*. 'Tis always jointed like a Cane, and is full of sweet Juice, like the Sugar Cane; and a Syrup as sweet as Sugar may be made of it, as hath been often tryed. And Meat sweetned with it, hath not been distinguished from the like sweetned with Sugar. At every Joint there are long Leaves almost like Flags, and at the top a Bunch of Flowers, like the Blossoms of Rye.

It is planted between the middle of *March* and the beginning of *June*; but most commonly from the middle of *April* to the middle of *May*.

In the more Northerly Parts they have a peculiar kind call'd *Mohausk-Corn*, which, tho planted in *June*, will be ripe in Season. The Stalks of this kind are shorter, and the Ears grow near to the bottom of the Stalks, and are generally of divers Colours.

The manner of planting is in Rows, at equal distance every way, about 5 or 6 Feet.

They open the Earth with an Hoe, taking away the Surface 3 or 4 Inches deep, and the breadth of the Hoe; and so throw in 4 or 5 Grains, a little distant one from another, and cover them with Earth. If two or three grow, it may do well, for some of them are usually destroyed by Birds, or Mouse-Squirrels.

The Corn grown up an Hand's length, they cut up the Weeds, and loosen the Earth about it, with a broad Hoe, repeating this Labour as the Weeds grow. When the Stalk begins to grow high, they draw a little Earth about it, and upon the putting forth of the Ear, so much as to make a little Hill, like a Hop Hill; after this they have no other Business about it till Harvest.

After 'tis gathered, it must, except laid very thin, be presently stripped from the Husks, otherwise it will heat, grow mouldy, and sometimes sprout: The common way (which they call Tracing) is to weave the Ears together in long Traces by some parts of the Husks left thereon. These Traces they hang upon Stages, or other Bearers within Doors, or without: For, hung in that manner, they will keep good and sweet all the Winter after, tho exposed to all Weathers.

The Natives commonly thresh it as they gather it, dry it well on Mats in the Sun, and then bestow it in Holes in the Ground (which are their Barns) well lined with withered Grass and Mats, and then covered with the like, and over all with Earth; and so it's kept very well, till they use it.

The *English* have now taken to a better way of Planting by the help of the Plow, in this manner: In the Planting-time they plow single Furrows thro the whole Field, about 6 Foot distant, more or less, as they see convenient: To these they plow others across at the same distance. Where these meet they throw in the Corn, and cover it either with the Hoe, or by running another Furrow with the Plow. When the Weeds begin to over-top the Corn, then they plough over the rest of the Field between the planted Furrows, and so turn in the Weeds. This is repeated where they begin to hill the Corn with the Hoe; and so the Ground is better loosened than with the Hoe, and the Roots of the Corn have more liberty to spread.

Where any Weeds escape the Plow, they use the Hoe.

Where the Ground is bad and worn out, the *Indians* us'd to put 2 or 3 of the Fishes call'd *Aloofes*, under or adjacent to each Corn-hill, where they had many times a Crop double to what the Ground would have otherwise produced. The *English* also have learn'd the like Husbandry, where these *Aloofes* come up in great Plenty, or where they are near the Fishing-stages; having there the Heads and Garbage of Cod-fish in abundance, at no charge but the fetching.

The Fields thus ploughed for this Corn, after the Crop is off, are almost as well fitted for *English* Corn, especially Summer Grain, as Peason or Summer Wheat; as if lying fallow, they had a very good Summer Tilth.

The *Indians*, and some *English* (especially in good Ground, and well fish'd) at every Corn-hill, plant with the Corn a kind of *French* or *Turkey* Beans: The Stalks of the Corn serving instead of Poles for the Beans to climb up with. And in the vacant laces between the Hills, they will plant Squashes and Pompions, loading the Ground with as much as it will bear. And many, after the last Weeding, sprinkle Turnep-feed between the Hills, and so, after the Harvest, have a good Crop of Turneps. The Stalks of this Corn, cut up before too much dried, and so laid up, are good Winter-Fodder for Cattle. But they usually leave them on the Ground for the Cattle to feed on. The Husks about the Ear are good Fodder, given for Change sometimes after Hay. The *Indian* Women slit them into narrow Parts, and so weave them artificially into Baskets of several Fashions.

This Corn the *Indians* dressed several Ways for their Food; sometimes boiling it whole till it swell'd and became tender, and so either eating it alone, or with their Fish or Venison instead of Bread; sometimes bruising it in Mortars, and so boiling it; but commonly this way, viz. by parching it in Ashes or Embers, so artificially stirring it, as without burning to be very tender, and turn'd almost inside outward, and also white and flowery. This they sift very well from the Ashes, and beat it in their wooden Mortars with a long Stone for a Pestle, into fine Meal. This is a constant Food

Food at home, and especially when they travel, being put up in a Bag, and so at all times ready for eating either dry or mixt with Water. They find it very wholesom Diet: And the *English* sometimes for Novelty will procure some of this to be made by the *Indian* Women, adding Milk or Sugar and Water to it, as they please.

The *Indians* have another sort of Provision out of this Corn, which they call sweet Corn. When the Corn in the Ear is full, while it is yet green, it hath a very sweet Taste. This they gather, boil, and then dry, and so put it up into Bags or Baskets for their use; boiling it again, either whole, or grossly beaten, when they eat it, either by it self, or amongst their Fish, or Venison, or Beavers, or other Flesh, accounting it a principal Dish.

These green and sweet Ears they sometimes roast before the Fire, or in the Embers, and so eat the Corn; by which means, they have sufficient supply of Food, tho their old store be done.

The *English*, of the full ripe Corn ground, make very good Bread: But 'tis not ordered as other Corn, For if it be mixed into stiff Paste, it will not be so good, as if made only a little stiffer than for Puddings, and so baked in a very hot Oven, standing therein all Day, or all Night. Because upon the first pouring of it on the Oven Floor, it spreads abroad, they pour a second Layer or heap upon every first, and thereby make so many Loaves, which if baked enough, and good, will be of a deep yellowish Colour; if otherwise, white.

It is also sometimes mixed with half, or a third part of Rye or Wheat-meal, and so with Leaven or Yeast, made into Loaves of very good Bread.

Before they had Mills, having first watered and husked the Corn, and then beaten it in wooden Mortars, the coarser part sifted from the Meal, and separated from the loose Hulls by the Wind, they boiled to a thick Batter: to which, being cold, they added so much of the fine Meal as would serve to stiffen it into Paste, whereof they made very good Bread.

The best sort of Food which the *English* make of this Corn, is that they call Samp. Having first watered it about half an Hour, and then beaten it in a Mortar, or else ground it in a Hand or other Mill, into the bigness of Rice, they next sift the Flower, and winnow the Hulls from it; then they boil it gently till it be tender, and so with Milk, or Butter and Sugar, make it into a very pleasant and wholesome Dish.

This was the most usual Diet of the first Planters in these Parts, and is still in use amongst them, as well in Fevers as in Health; and was often prescribed by the learned Dr. *Wilson* to his Patients in *London*. And of the *Indians* that live much upon this Corn, the *English* most acquainted with them, have been informed by them, that the Disease of the Stone is very seldom known amongst them.

The *English* have also found out a way to make very good Beer of this Grain, that is, either of Bread made hereof, or else by Malting it. The way of making Beer of Bread, is by breaking or cutting it into great Lumps, about as big as a Man's Fist, to be mashed, and so proceeded with

as Malt, and the impregnated Liquor, as Wort, either adding or omitting Hops, as is desired.

To make good Malt of this Corn, a particular way must be taken. The Barley Malt-masters have used all their Skill to make good Malt hereof the ordinary way, but cannot effect it; that is, that the whole Grain be malted, and tender and flowry, as in other Malt. For it is found by Experience, that this Corn before it be fully malted, must sprout out both ways, *i. e.* both Root and Blade to a great Length, of a Finger at least, if more, the better. For which, it must be laid upon an Heap a convenient time; wherein on the one hand, if it lieth of a sufficient thickness for coming, it will quickly heat and mould, and the tender Sprouts be so entangled, that the least opening of the heap break them off, and so hinders the further Maturation of the Grain into Malt; On the other, if it be stirr'd and open'd to prevent too much heating, the Sprouts which have begun to shoot, cease growing, and consequently the Corn again ceaseth to be promoted to the mellowness of Malt.

To avoid all these Difficulties, this way was tried and found effectual. Take away the top of the Earth in a Garden or Field 2 or 3 Inches, throwing it up half one way and half the other; then lay the Corn for Malt, all over the Ground so as to cover it, then cover the Corn with the Earth that was pared off, and there is no more to do, till you see all the plat of Ground like a green Field, covered over with the sprouts of Corn, which will be within 10 Days or a Fortnight, according to the time of the Year; then take it up and shake the Earth from it, and dry it; for the Roots will be so intangled together, that it may be raised up in great Pieces. To make it very clean, it may be washed, and then presently dry'd on a Kiln, or in the Sun, or spread thin on a Chamber-Floor.

This way every Grain that is good will grow, and be mellow, flowry and very sweet; and the Beer made of it, will be wholesom, pleasant and of a good brown Colour; yet Beer made of the Bread as aforesaid, is as well coloured, as wholesome and pleasant, and more durable, this therefore is most in use.

Improve-
ment to be
made by
Maize, by
Sir Richard
Bulkley. n.
205. p. 928.

X. 1. The greatest Profit that ever I have heard of the Field White Pease, has been 20 Barrels reap'd for one sown; But Maize will yield more than 2000 for one. I made an experiment in *Ireland*, with a Grappe of 8 Sides, or Rows, having in each 30 Grains, (which grew in *Brandenburg*) in good Orchard Ground, which had been indeed dung'd for some other Legumes the last Year, and sow'd them in Rows; each Row being about a Yard asunder, and each Grain about a Foot asunder in the Row, taking care to preserve them from the Mice till above Ground. Now out of each Grain come up 3, 4, 5 or 6 Stems, (my *Swiss* says, he rarely has seen above 2 or 3 elsewhere) every of which Stems had 4, 3 or 2 of these Grappes. So that we may suppose, that each Grain will give 3 strong Stems, and each of these Stems 3 Grappes, and each Grappe 240 Grains, which makes 2160 for one.

There

There are some things very odd in the manner of its Growth, it first sends up a thick reedy Stalk, about a Yard high, with long Leaves of a very thick woody Substance, and half a Yard long enwrapping the Stalk, just like the *Iris*. At the top of this Stalk, when the Leaves open, there appear 20 or 30 Ears, as it were of our unripe Wheat, but this when it is opened must be plucked away, for it is nothing but the Flower; and what is most surprising, the Fruit comes not where the Flower was, but on the inner side of every Leaf, where it joyns to the Stem, comes forth, after a time, a large Shoot, thicker than ones Wrist, at the end of which hangs out a bundle of fine Strings, like a Horse-tail, which is the true Flower of the Plant. As this withers, the Fruit grows on within, being envelop'd in a great number of Leaves, which when they are withered, the Fruit is ripe, (but is never naked while on the Stalks) and must then be taken off, and hung up to dry, or kept in Chests. It will serve for all the uses of the White Pea (to which Grain it is the most like in Taste and Figure) either in Bread, (with Wheat) or Soup, or Pudding, or with Pork.

2. If the Maize be equal in goodness to Peas, and an Acre planted with it, it will certainly yield more than one sown with Pease, without impoverishing the Land, then indeed it will be advantageous to plant it; but if only an equal Quantity, then tho one Grain should yield a 1000 fold, all the Advantage will be in the difference of the Seed, which is not very considerable; and which the Compendium of sowing above setting may in some measure countervail.

By Sir Richard's Description of it, I am confirm'd in my Opinion, That there are two really distinct Species of Maize; for what I have seen cultivated in Gardens, and have my self planted, ariseth to double the Stature he ascribes to this, that is, 7, 8, or 10 Feet; and besides, withus, never brings the Seed near to Perfection. But that I have seen planted in the Fields in *Germany*, is of about the same height with Sir Richard's, and ripens the Seed. *Lobel* also acknowledges two sorts thus differing.

XI. A Distiller with us (at *Newcastle*) hath made a quantity of an extraordinary Spirit of Sugar. It seems to be the Result of some anomalous Fermentation: It is so strong that no Man is able to smell it in an open Vessel, without being made almost breathless; neither do I think the Person that made it, can make it again. It was drawn from bare Sugar-water (which is nothing but the Water wherewith the Molds, Aprons, &c. are washed) fermented with the Scum; and it was so exceedingly Volatile, that it would not be carried, but lost all its Force in the Carriage, tho it was very well stop'd.

XII. Saffron-heads planted in a black rich sandy Mold, or in a mixt sandy Land, between white and red, yields the greater store of Saffron. A Clay, or stiff Ground, be it never so rich, produceth little Saffron, tho Increase of Heads or Roots, if the Winter prove mild and dry; but the extremity of Cold and Moisture will rot them. So that the finest light sandy Mold, of an indifferent Fatness, is esteemed most profitable.

M m m m 2

Plow

*Consider'd
by Mr. J.
Ray, ib. p.
930.*

*An extra-
ordinary
Spirit of
Sugar, by
Dr. Lucas
Hodgeson, n.
130. p. 766.*

*The Culture
of Saffron,
by Mr. Ch.
Howard. n.
138. p. 945.*

Plow the Ground in the beginning of *April*, and lay it very smooth and level.

About 3 Weeks or a Month after, spread upon every Acre 20 Loads of rotten Dung, and plow it in.

At *Midsummer* plow it again, and plant the Saffron-Heads in Rows, every way 3 Inches distant one from another, and 3 Inches deep.

The most expedite way of Planting, is to make a Trench the whole length of the Field, 3 Inches deep, with a Spit-shovel. The Spit-shovel is to be made of a thin streight Iron 10 Inches long, and 5 Inches broad, with a Socket in the side of it to put to a Staff or Handle. Lay the Saffron-heads 3 Inches distant in the Trench, and with the Shovel spit up 3 Inches of Earth upon them.

Observe this Order in planting of whole Fields, whereby the Heads will lie every way 3 Inches one from another. Only Paths or shallow Trenches are to be left 2 or 3 Yards asunder, which serve every Year to lay the Weeds to rot, that are to be weeded and pared off the Ground.

As soon as the Heads begin to shoot or speer within the Ground, which is usually a Fortnight before *Michaelmas*, hoe or pare the Ground all over very thin, and rake lightly all the Weeds and Grass very clean, lest it choak the Flowers, which will soon after appear; and are then to be gather'd, and the Saffron to be picked and dried for use.

The Ground must be very carefully fenced from Sheep or Cattle, which by treading break the Saffron-grass, and make the Chives come up small.

In *May*, the Saffron-grass will be quite withered away; after which the Weeds and Grass the Ground produceth, may be cut or mowed off from time to time to feed Cattle till about *Michaelmas*, at which time the Heads will begin to speer within the Ground. Then hoe, pare and rake the Ground clean as before, for a second Crop. The like Directions are to be observed the next Year for a third Crop. The *Midsummer* following, dig up all the Saffron-heaps, and plant them again in another new Ground, dunged and ordered as aforesaid, wherein no Saffron hath been planted, at least not within 7 Hours.

The Flowers are to be gathered as soon as they come up, before they are full blown, whether wet or dry.

Pick out the Chives clean from the Shells or Flowers, and sprinkle them 2 or 3 Fingers thick, very equally on a double Saffron-paper. Lay this on the Hair-cloth of the Saffron-Kiln, and cover it with 2 or more Saffron-papers, a piece of woollen Cloth, or thick Bays, and a Cushion of Canvas, or Sackcloth, fill'd with Barley-straw, whereon lay the Kiln Board.

Put into the Kiln, thoroughly kindled, Charcoal, Oven-Coals, or the like, keeping it so hot, that you can hardly endure your Fingers between the Paper and the Hair-cloth.

After an Hour or more turn in the Edges of the Cake with a Knife, and loosen it from the Paper. If it stick fast, wet the out-side of the Paper with a Feather dipt in Beer, and then dry the Papers. Turn the Cake, that both sides may be of a Colour.

If it stick again to the Paper, loosen it, and then dry it with a very gentle Heat, with the addition of a quarter of 100 l. Weight laid upon the Kiln-board.

The Saffron Cake being sufficiently dried, is fit for use, and will last a good many Years, being wrapt up and kept close.

The best Saffron is that which consists of the thickest and shortest Chives, of a high red and shining Colour, both without and within alike.

Saffron is oftentimes burnt, and in Knots, spotted and mixed with the Yellows that are within the Shells.

It's usually observed, that one Acre doth yield, at the least, 12 Pounds of good Saffron one Year with another; and some Years 20 Pounds.

Good Saffron is seldom or never sold at so low a Rate as 30 Shillings *per* Pound, frequently at 3 Pounds *per* Pound, and upwards. Wherefore one Acre bearing 12 Pounds at 40 Shillings *per* Pound, cometh to 24 Pound *per* Annum.

The gathering and picking of one Pound of Saffron is worth one Shilling, which cometh to 12 Shillings *per* Acre.

The Fire and Care of drying may come to 3 Shillings more, at 6 Pence the Pound; which is in all 15 Shillings.

The Grass that is mow'd and cut off the Ground for the use of Cattle, will be very near worth as much as will countervail the picking and drying the Saffron; the Soil being enriched, not only by the Dung, but the Saffron it self, as appears by the rich Crops the Ground yields for several Years after, without any other Manuring or Improvement.

Sixteen Quarters of Saffron-Heads are sufficient to plant one Acre. A Quarter of these Heads is usually sold in the Place for 10 Shillings, which comes to 8 Pounds *per* Acre.

Twenty Loads of rotten Dung laid on the Ground, may be worth 40 Shillings at 12 Pence a Load for the Dung, and as much for Carriage into the Field.

For thrice ploughing the Ground 20 Shillings.

For planting the Heads about 4 Pounds. Which in the whole makes 14 Pounds the Charges of planting an Acre, which will bear 3 Crops.

So that all things reasonably computed, it appears that an Acre of Saffron will be worth, notwithstanding all Casualties, one Year with another, over and above the 14 Pounds charges, for the first Year's Planting (at the least) 20 Pounds *per* Annum: Besides the great Increase of the Saffron-Heads, which will be as three for one.

The Kiln consists of an Oaken Frame, lathed on every side; 12 Inches square in the bottom, 2 Foot high, and 2 Foot square at the Top; upon which is nailed a Hair-cloth, and strained hard by Wedges drove into the sides; a square Board, and a Weight to press it down, weighing about a quarter of an Hundred.

The Insides of the Kiln are covered all over with the strongest Potters Clay, very well wrought with a little Sand, a little above 2 Inches thick.

The Bottom must be lined with Clay 4 or 5 Inches thick, which is the Hearth

Hearth to lay the Fire on : Level wherewith is to be made a little Hole to put the Fire. The outside may be plastered all over with Lime and Hair.

Melons or-
der'd by M.
De la Quin-
cinay. n. 45.
P. 901.
Fig. 159.

XIII. The first thing appearing of Melons are two Leaves united, here call'd Ears (mark'd 11.) out of the midst of these two Ears there shoots some Days after, first one Leaf, which call the first Leaf or Knot (marked 2) and out of the same place, after some Days more, shoots a second, call'd the second Knot (mark'd 3.) out of about the midst of the Stalk of this second Knot shoots the 3d Knot (mark'd 4.) And this 3d Knot it is, which must be cut at the place mark'd 6, without hurting the Branch of the 2d Knot, whence this third came ; because that from that Place will spring a Branch, which we call the first Arm, and this Arm will shoot forth first one Knot, then a second, then a third ; and this third it is you are to cut again in the same manner, as was said before. And you must be careful to cut these third Knots, without staying for the shooting of the 4th or 5th one. You'll see out of every Knot come forth Arms or Branches like to the first, spoken of before ; and it is at those Arms, that the Melon will be produced. And they will be good, if the Foot or Root be well nourish'd in good Earth, and cherish'd by a good Hot-Bed and the Sun. But let the Foot of the Melon never pass into the Dung, nor the Earth be watered but moderately, when you see it grows too dry, so as the Shoot might thereby suffer ; which yet you must not delay till it happen, lest the Remedy come too late. I water twice or thrice a Week in very hot Weather, and that about Sun-set ; and I cover my Melons with a Straw-Mat from 11 in the Forenoon, to 2 in the Afternoon, when the Heat of the Sun is too violent, and too quickly consumes that little Moisture necessary for the Root. And when it raineth, I cover also my Melon-Garden, lest too much Wet hurt my Fruit.

If the Root produce too many Branches or Arms, cut away the weakest of them ; and leave none but 3 or 4 of the strongest and most vigorous, and such as have their Knots nearest to one another. When I transplant my Melons from the Nursery-bed, I put commonly 2 Roots together, except I find one very strong ; which I then plant alone, cutting from it neither of the Branches that shoot from each side (mark'd 77) betwixt the one Ear and the Leaf before spoken of. But when I join two Roots together, I quite cut away both the Branches that shoot from the two Ears, standing one over against the other, to avoid the disordering abundance of Branches ; which also would wrong the Foot.

The Melons being knit, I leave but two of them upon each Foot ; chusing those that are best placed, and next to the first and principal Stalk, that is to the Heart of the Foot. I also take care, to leave none but fair Ones, and such as have a short and thick Tail. The Foot also of your Melon must be short, well truss'd, and not far distant from the Ground. Melons of a long Stem, and having the Stalk of the Leaf too long and slender, are never vigorous ; and cannot yield good Melons.

It happens sometimes, that at the very first, there shoot out, from between the two Ears, two Leaves, tho I above spoke but of one : But this happens

happens but seldom, and when it does, such two Leaves must be reckoned but for one Knot; and afterwards there will shoot out a second, then a third, &c. and so on to 25 or 30, if you be not careful to cut in time. And it is at the Extremity of those Branches so distant, that Melons will grow: But they cannot be good, because they are so far from the Place, which affords them their Nourishment.

I must not forget to tell you, that from the midst betwixt the two Ears, and the two first Leaves, there shoots out yet one Branch more, which ought to be kept if vigorous, but cut if weak.

He that is curious must every Day walk often in his Melon-Garden, to cut off all the Branches which he shall observe to be useless or hurtful.

Whenever you have a Melon, which comes well knit on a Branch, you ^{n.46.p.983.} must not fail to cut away the rest of that Branch, on this side of the Fruit: To the end that all the Nourishment, that would have been dispersed into the whole Branch, may pass into that Fruit, which is found at the Extremity of the Branch; taking care notwithstanding, that the Fruit be covered with some Leaves of the other Branches, for its better Growth under the Shade, in those Parts where 'tis very hot.

There commonly needs no more than 40 Days from the time of a Melon's knitting to that of its Ripeness.

For the keeping of the Seed, you must take no other Seed but such as is found in that part of the Melon, which hath been towards the Sun: And at the same time you eat the Melons, you must well clean such Seeds, and rub them with a Linen Cloth, until they be very clean and dry; then put them up in some convenient Closet till Seed-time.

Remember not to eat the Melons but some 24 Hours after they have been gathered; putting them in the mean time in a dry place, neither too hot nor too cold, and free from any dry Seents, good or ill.

Observe also, to gather them seasonably, when they are neither too ripe nor too green, which you may know by their yellowish Colour, and by their Tail commonly splitting, and their Smell. A Melon ordinarily requireth one Day from the time of its being smitten, to that of its being gathered. I call that the time of its being smitten, when it begins to shew its being ripe by a little yellowness appearing in some part or other of it. A Melon that ripens too fast, is never good, such a Ripeness not being a good one, but proceeding from the poorness or sickness of the Foot, which maketh it thus turn suddenly.

The Melon must be full, without any Vacuity, which, you know, is discerned by knocking upon it. And the Meat must be dry, no Water running out: Only a little Dew is to appear, issuing out of the Pulp; which must be of a very Vermilion Colour.

Trouble not your self to have big Melons, but good ones. Those who covet great Melons, may have their Desires, either by sowing Seeds of the great Kinds, or by much watering others: Which watering is a thing, wherein great Care and Discretion is to be used. You may judge of the necessity

necessity of watering by the Vigour which is required in the Foot and Leaves, without which the Fruit cannot be good for want of good Nourishment.

Dog-Mercury; By Mr. T.M. n. 203. p. 875.

XIV. 1. About 3 Weeks ago the Wife of one *W. Mathews* near *Salop* gathered some Herbs, and (having first boil'd them) fryed them with Bacon for her own and her Family's Supper. And after they had been about 2 Hours in Bed, one of the Children (which is dumb, and about 7 Years old) fell very sick, and so did the other 2 presently after; which obliged the Man and his Wife to rise, and take the Children to the Fire, where they vomited and purged, and within half an Hour fell fast asleep. They took the Children to bed as they were asleep, and they themselves went to bed too, and fell faster asleep than ever they had done before. The Man waked the next Morning about 3 Hours after his usual time, went to his Labour at *Mr. Newport's*, and so by the Strength of his Constitution carried it off: But he says he thought his Chin had been all the Day in a Fire, and was forced to keep his Hat full of Water by him all the Day long, and frequently dipt his Chin in it as he was at his Work. The Woman wakened a while after her Husband, and being forced to it, got up to look after her little Family Concerns: But she was very sick, and has continued so till within these few Days, since which she is very well recovered. One of their Children slept from that Night (which was Thursday 3 Weeks) till Monday Evening following, and then (having just only opened her Eyes and made two Sprunts, without speaking one Word) died immediately. While she was asleep, Endeavours were used to waken her, but in vain. The other two Children slept about 24 Hours, and upon their waking fell a vomiting and purging again, which I think saved their Lives. *Mathews* told me he never eat so pleasant an Herb in his Life: But 'tis observ'd that the Cattle never browse it. 'Tis branched and seeded like Spinnage or Mercury, but leaved rather like Lake-weed; the Leaves are dented too.

By Dr. Sloan, id. p. 876.

2. Mr *Will. Baxter* did me the Favour to send for a dry'd Sample or Specimen, and it proves to be Dog-Mercury; the Stalks, Leaves and Spikes agreeing exactly in every thing with those of Dog-Mercury or *Mercurialis perennis repens*, *Cynocrambe dicta*, *J. R.*

Hemlock, by Dr. Nath. Wood. n. 231. p. 636.

XV. A Gentleman of my Acquaintance having a Horse which was troubled with that stubborn Disease they call the Farcy, employed several usually efficacious Medicines unsuccessfully. At length being in a Place where grew a great Quantity of Hemlock, he observed the Horse began to feed thereon greedily, eating it up. On which within 3 or 4 Days his Sores dried up, and he recovered very fast. From whence it appears, that the Leaves at least of Hemlock are not noxious to some Animals, but rather salutary. The Seeds also some Birds, as in our Observation Bustards, will greedily eat.

XVI. 1. A certain Woman near *Kilkenny* in *Ireland* eating by mistake some Root, I suppose of common Hemlock, among Parsneps, was immediately seiz'd with Raving and Madnes, talked obscenely, and could not forbear Dancing. Thus she continued for some time, till at length she was taken with Epileptick Fits: Of which Distemper being committed to my Charge, she was soon cured by the common Method, and has now for several Years lived in perfect Health. What quantity she eat is not known: But a piece of Hemlock Root was found on her Trencher.

A Poisonous Root like Hemlock; By Dr. Nath. Wood, n. 231. p. 634.

2. I am in some doubt whether it was really the Root of Hemlock, which this Woman did eat, and which had this Effect upon her, and not some other: Because, 1. *Jo. Bauhine*, relating two parallel Stories of the effects of Roots which were taken for Parsneps, is of Opinion that they were the Roots of Wild-Cicely, *Cicutaria Vulgaris*, or *Myrrhis Sylvestris*: Because (saith he) the Roots of it are more like to Parsneps, than those of *Cicuta* or *Hemlock*. 2. *Mr. Ja. Petiver* assured me, that he saw one *Mr. Henly* eat 3 or 4 Ounces of Hemlock-Root without the least harm: Whereupon he himself was encouraged to do the like, eating about half an Ounce. They tasted somewhat like the Root of *Seleri*, or Sweet-smallage: And he perceived no ill Effect, or Inconvenience from the eating of them. 3. The common People generally believe that the Roots which cause these Symptoms, are no other than old Parsneps, which have continued some Years in the Ground; and therefore call them Madneps.

By Mr. J. Ray. ib. p. 635. Hist. Plant. Tom. 3. p. 181.

XVII. 1. Eight young Lads (about 30 Years ago) went a Fishing to a Brook near *Clonmell* in *Ireland*, and there meeting with a great Parcel of *Oenanthe Aquatica Succo Viroso* (in *Irish* *Tahow*) they mistook the Roots of it for *Sium Aquaticum* Roots, and did eat a great deal of them. About 4 or 5 Hours after going home, the eldest of them, who was almost of Man's Stature, without the least previous appearing Disorder or Complaint, on a sudden fell down backwards, and lay kicking and sprawling on the Ground: His Countenance soon turned very ghastly, and he foamed at the Mouth. Soon after 4 more were seized the same way, and they all died before Morning; not one of them having spoken a Word from the Moment in which the venenate Particles surprized the *Genus Nervosum*. Of the other three, one run stark mad, but came to his right Reason again the next Morning; Another had his Hair and Nails fall off; and the third (who is my Brother-in-Law, and from whom I had this Account) alone escaped, without receiving any harm. Whether he eat less of this fatal Root, or whether his Constitution, which is to this day very Athletick, occasioned it, I cannot tell. Tho I am of opinion that his speedy running above 2 Miles home, after that he saw the first young Man fall, together with his drinking a very large Draught of Milk, warm from the Cow, in his Mid-way, were of singular use to him. For his violent Sweating did doubtless expel and carry off many of the venenose Particles, and had a better Effect than perhaps the best of our *Alexipharmicks* (which you know are generally *Diaphoretick*) might have produced in this Case. Besides, I believe, the Draught of

Hemlock-Water-Dropwort; By Mr. Er. Vaughan, n. 238. p. 84.

warm Milk did act its part, by involving the acid or acrimonious poisonous Particles, and rendring them unactive, and preventing their seizing the Genus Nervosum, till they were expelled per Diaphoresin.

There was also a Dutchman about 2 Years since, within 8 Miles of Clonmel, poisoned by boyling and eating the Tops of this Plant shred into his Pottage. I believe he took it for *Apium Palustre*, which its Leaves much resemble.

By Mr. Ray, 2. Several parallel and no less tragical Histories of later Date, of the
ib. p. 86. miserable Destruction of divers Persons, by the eating of the Roots of this
De Nox. Ci- pernicious and deleterious Plant, I find recorded by Jac. Wepferus, and in
cusa. Aquat. the *Miscellanea Curiosa*, Dec. 2. An. 6.

The Horned XVIII. Between Penzance and Marketjew in Cornwall, on the sandy Shore
Poppy; By grows abundance of *Papaver Corniculatum Luteum*, or Horned Poppy, with a
Mr. Ja. New- yellow Flower, vulgarly called in Hampshire and Dorsetshire, *Squatmore*, or
ton. n. 242. *Bruise-Root*, (as I was there informed) where they use it against Bruises ex-
P. 263. ternal and internal. One Charles Worth, dwelling at the half-way House
between Penzance and Marketjew, caused a Pye to be made of the Roots of the
said Poppy, supposing them to be *Sea-Holly* or *Eringo-Roots* (for they had made
Pyes thereof, which were very pleasant to them) but the eating of the afore-
said Pye, whilst hot, was presently taken with such a kind of *Delirium*, that
he call'd for a white earthen Chamber-Pot, and after having purged by
Stool into it, he broke it into pieces, and bid the By-standers to save them,
for they were all Gold. The Man and Maid-servants, having also eat of the
same Pye, became delirious, and fancied that most what they saw was Gold.
A Child in the Cradle having also tasted of the Pye, was much dosed, and
turned its Mouth to and again. And thus they continued for some Days,
and then became well.

Perhaps the yellow Colour of the Flowers running in their Minds, which
the eating of the Roots had now deprav'd, might beget that Idea of Gold in
them.

The Helmon- XIX. There are two sorts of the *Helmontian Laudanum*; the one used by
tian Lauda- the elder *Helmont*, the other by his Son. The former was a great Secret
num; By communicated to me by an expert Chymist about 15 Years ago: Which be-
Mr. Boyle. cause I have not leave to publish, meeting about 2 Years ago with that
n. 107. P. obliging and very ingenious Person F. M. Baron Van Helmont, Son to the fa-
147. mous *Johannes Baptista*, I obtained from him by Word of Mouth, some Di-
rections about the *Laudanum* he uses; which tho he confessed, and I soon
perceived, to be differing from his Father's, yet he seem'd to think it not
inferiour and more parable.

I soon after committed it to Writing, lest it should slip out of my Me-
mory, and I had his Permission to communicate it for the publick Good.

Take of *Opium* a quarter of a Pound, and of the juice of *Quinces* 4 Pound
at the least; the *Opium* being cut into very thin Slices, and then as 'twere
minc'd

minc'd to reduce it into smaller parts, is to be put into, and well mixed with the Liquor, (first made luke-warm) and fermented with a moderate Heat for 8 or 10 Days, rather more than less. Then filter it, and having infused in it of *Cinnamon*, *Nutmeg* and *Cloves*, of each an Ounce, or an Ounce and half, let them stand 3 or 4 Days more; if it be a full Week, it may be so much the better. Then filter the Liquor once more, having let it boil a Walme or two after the Spices have been put in. This being done, evaporate away the superfluous Water to the consistence of an Extract, or to what other consistence you please.

Lastly incorporate very well with it two Ounces of the best Saffron reduced to fine Powder, or as much Extract as can be obtain'd from that quantity of Saffron.

According to the Consistence you desire to have your Medicine of, you may order it so, as either to make it up into a Mass of Pills (in which Form I have caused it to be given) or keep it in a liquid Form; but in this latter Case the Evaporation must have been made more sparingly, that after the putting in of the Saffron, or its Extract, it may not grow too thick. In this Form the Dose may be from 5 or 6 Drops to 10 or fewer, according to Circumstances; and of the Pills a somewhat less quantity is required.

XX. One *Mustapha Shatoor* an Inhabitant of *Sediqui*, a Village 6 Miles from *Smyrna*, by Trade a Coffee-Man, about 45 Years old, a most famous *Opium-Eater*, told me, that his constant eating was 3 Drachms a Day of crude Opium, one half of which was his Dose in the Morning, and the other half in the Afternoon: But that he could safely take double this Quantity.

*The Use of
Opium among the
Turks; By
Dr. Edward
Smith. n.
221. p. 288;*

Resolving therefore to be an Eye-Witness of what he could do, I provided the best *Opium* I could get, and weighed it nicely into Drachms. He came to me at my desire, at 9 in the Morning, but excused his having taken half a Drachm before, because he had not Strength to rise out of his Bed without it. I laid before him my *Opium* made up in Pills, each weighing a Drachm, and desired him to eat what he pleased. He took one Drachm and a half, making it up in 3 Pills, and chewing it with a little Water: He commended the *Opium*, but was not willing to eat more at that time, and I would not press him for fear of Accidents. He stayed with me about half an Hour after he had eaten the *Opium*: The visible Effects it had upon him were to make his Eyes sparkle, and to give a new air of Life and Brightness to his Face. He told me that he was extremely refresh'd by my Entertainment; and I found him half an Hour afterwards labouring heartily at cleaving Wood to burn. At 3 in the Afternoon he came to me again, and took the same Quantity as in the Morning, and appeared after it with the same Symptoms. He says that it has always the same Effects, giving him Vigour and Spirit, and is now become as necessary to him as any other part of his Sustenance; that it makes him fitter for Procreation, for he has many Wives and Children; that it never affects him with Sleep and Drowsiness, but rather hinders his Reposing, when he happens to take too much of it; that he entered upon

this Practice 25 Years ago, beginning with the bigness of a Grain, and so training up Nature gradually to larger Quantities; and that the want of it, and the desire of taking more, grows daily upon him.

The Alteration and Impairment which this Custom hath produced in him are Weakness, his Legs being small; his Gums eaten away, so that the Teeth stand bare to the Roots, his Complexion very yellow, and appearing older by 20 Years, than he really is.

Opium is commonly taken by the Messengers in *Turkey*, who are employed in making quick Dispatches; 'tis generally part of their Provision, they take it when they find themselves tired, and it gives them Strength and Spirit to proceed. I had the following Relation of one of them, that coming from *Constantinople* to Mr. Sam. Barnardiston, a Merchant of *Smyrna*, at entering into the Gentleman's House, he fell down for dead; at which, when the whole House was surprized and concerned, one of the Servants rightly judging that this Fainting away was occasioned by the stock of Opium laid in for his Journey being spent, forced a little of it into his Mouth, and by this means he presently recovered, and acknowledged the Servant had been his Physician.

The *Turks* use Opium made up with something that renders it palatable, at their Feast call'd *Biram*, to make them cheerful; which may be one Reason of its prevailing so much: For finding it then entertains them with pleasing Fancies, they are tempted to continue it, and so the use of it becomes necessary, and grows upon them.

Mackenboy;
By the Rp.
of Cloyne, n.
243. p. 294.

XXI. The famous *Irish* Herb call'd *Mackenboy*, or *Tithymalus Hibernicus*, is reported by the Natives to be so strong a Purge, that even the carrying it about one in their Clothes is sufficient to produce the Effect. But Dr. *Mullen* has lately proved this Story to be false, by carrying its Roots for 3 Days in his Pocket, without any alteration of that sort.

The Snake-
Root, By
Mr. J. Ban-
nister. n.
247. p. 467.

XXII. The *Pistolochia*, or *Serpentaria Virginiana* hath a bushy Root, consisting of a number of small Strings of a yellowish Colour, and hot aromatick Scent and Taste: Thence grow one or two smooth, at least very little hairy, Stalks; round, and most commonly upright, not square nor trayling. The Leaves grow alternately on this side and that, one at a Joint or Knee: They are thin, long and pointed, coming like a Heart at the Foot-Stalk; a little hairy above, and rough, with many protuberant Veins underneath; and in handling they stick a little to the Fingers. Near the Ground grow one or two hollow Flowers, each upon its proper Foot-Stalk, different in Form from the *Pistolochia Cretica*, or any other yet known: All whose Flowers resemble a Cow's Horn, the top growing to the Rudiment of the Seed Vessel, and the open end cut slaunting like a Drenching-Horn, whereas this of ours terminates with a Heel, which supports a broad, round, galerniculated Lip, the Center of which opens into the hollow of the Flower.

The

The Lip is of a light russet, or dirty Colour. The Seed-vessel is hexagonal, shap'd like a Pear when full grown, near half an Inch in Diameter. It is not an Ever-green, but after the Seeds are ripe, the Leaves and Stalks begin to wither and decay. It flowers in *May*, and its Seeds are ripe in *August*.

XXIII. *Succisa*, or *Devils-bit*, is excellent for Poisons, especially the Plague, and it is so powerful a Sudorific, laying the sick Person, whether of the Plague, or other malignant Fever, on a Bed of that Herb, moderately hot, he shall sweat till they take him off, and much more if he drink of the Decoction, or Juice of the Herb; which in Summer they take all, and in Winter of the Root only.

Devils-bit,
by Sir The.
Mayerne, n.
211. p. 166.

XXIV. *Alcanna* is the Leaf of a Plant, dried and powdered; which when steeped a Night in Wine, will dye the Nails red.

Alcanna,
n. 243.
p. 295.

XXV. *An. 1556*. An *Aloe Americana, serrato Folio*, being of a pale green Colour, and consisting of 11 Leaves, was bound about with a red dry Cloth, and was hung up without Oil, as is usual, in the Kitchen. It weighed,

Aloe Americana,
by
Dr. Merrer.
n. 25. p. 455.

		Weight				Loss.				Weight.				Loss.	
		℥.	℥.	℥.	gr.	℥.	gr.			℥.	℥.	℥.	gr.	℥.	gr.
<i>Aug.</i>	4	21	6	0	2	<i>May</i>	1.	<i>May</i>	1	20	7	0	0	1	0
<i>Aug.</i>	19	21	3	0	24	3	27	<i>May</i>	28	20	5½	0	0	1½	0
<i>Sept.</i>	6	21	1½	0	0	1	14	<i>June</i>	12	20	4	0	4	2	26
<i>Feb.</i>	20	21	1	0	12	0	11	<i>July</i>	1	20	1	0	8	2	18
<i>Mar.</i>	16	21	0	2	0	0	32	<i>Jul.</i>	20	19	6	0	1	3	7
<i>April</i>	8	21	0	0	0	0	40	<i>August</i>	4	9	3	0	12	2	40

So that in a whole Year it lost 2 Ounces, 3 Drums, 24 Grains. The succeeding Year, being drier and hotter, it lost 3 Ounces 2½ Scruples, and more than double in the 6 colder, than the 6 hotter Months. I kept it about 5 Years, and it decreased much about the same Proportion. And in the Year 1660, hanging it in a cold Garret, it perished.

These Observations I had about it, that every Year two of the greater Leaves first chang'd Colour, and withered; and in the Spring-time, there grew out two very fresh and green ones, never amounting to the bigness of any of the precedent. Insomuch, that all this time I had the same Number of Leaves. And then these new Leaves were more fresh and green, and not serrated, and thicker also in proportion to their other Dimensions. Whence perhaps it may probably be inferr'd, viz. from the Growth of these latter Leaves, that there's a Circulation in this Plant of the *Succus nutritivus*: For, how is it possible, that the Roots continuing as firm and solid as at first, should supply so much Nourishment, as to procreate new Leaves, unless it were

were from the Return of the said *Succus*, from the old and decaying Leaves into the Root, and there protruded for the Production of new ones? For all bulbous Roots, as Garlick, Onions, Tulips and especially Squills, which protrude their Leaves, placed in a Shop or House, have their Roots lighter and more spongy; the Leaves being formed out of the Substance of the Root, as a Chick out of the *Albumen*: In the mean while, the whole decreasing in Weight, as in the aforesaid Aloe.

The Tartarian Lamb,
an Lamb,
by Hans
Sloan,
n. 247. p. 461.
Fig. 160.

P. 386.

XXVI. Fig. 160. represents what is commonly, but falsely, in *India* called the *Tartarian Lamb*, sent down from thence by Mr. *Buckly*. This was more than a Foot long, as big as ones Wrist, having several Protuberances, and towards the End some Foot-Stalks, about 3 or 4 Inches long, exactly like the Foot-stalks of Ferns, both without and within. Most Part of the outside of this was cover'd with a Down of a dark yellowish Snuff-Colour, shining like Silk, some of it a Quarter of an Inch long. This Down is what is commonly us'd for spitting Blood, about 6 Grains of it going to a Dose, and 3 Doses pretended to cure such an Hemorrhage. In *Jamaica* are many Scandent and Tree-Ferns, which grow on, or to the Bigness of Trees, and have such a kind of *Lanugo* on them, and some of our Capillaries have something like it. It seem'd to be shap'd by Art to imitate a Lamb, the Roots or climbing Parts being made to resemble the Body, and the extant Foot-Stalks the Legs. This Down is taken notice of by Dr. *Merret*, at the latter End of Dr. *Grew's Mus. Soc. Reg.* by the Name of *Poco Sempie*, a Golden Moss, and is there said to be a Cordial. I have been assured by Mr. *Brown*, who has made very good Observations in the *East-Indies*, that he has been told there by those who have lived in *China*, that this Down or Hair is used by them for the stopping of Blood in fresh Wounds, as Cobwebs are with us: And that they have it in so great Esteem, that few Houses are without it. I have known it much used for spitting of Blood. But on Trials I have seen of it, tho I may believe it innocent, yet I am sure 'tis not infallible.

A sort of
Seeds which
clarify Water,
ter, by Dr.
Hans Sloan,
n. 249. p. 44.
Fig. 161.
n. 43. p. 863.

XXVII. I have several times seen a sort of Seeds, come from the Coast of *Cormandel* and *Malabar*, which are there used for clarifying Water. They are about the Bigness of a small Pea, only broader and flatter, having *Stria* run from their Center after the manner of the common *Nux Vomica*. The best Account I have had of the way of using them, was from Dr. *Brown*, who lived in the *East-Indies* some time; he says, they rub or grate them on the bottom of a small earthen Bason, wherein is contained some Water; this Water and Powder is put into a large Quantity of muddy or foul Water, which is by this clarified.

The true *Amomum*, or
Tugus of the
Philippine
Isles, by P.
Ge. Gamelli,
n. 248. p. 2.

XXVIII. *Racemoso Tugus*, seu *Birao*, aliis *Caropi*, viso *Florum fasciculo*, degustato ejusdem uvæ acinis, seu oblongo Semine; & facta collatione cum *Botanicorum Amomi Descriptionibus*; *Tugus legitimum Dioscoridis esse Amomum* decrevi.

Est autem *Tugus* Planta quandoque ultra Cubitos assurgens, Folio simili Plantæ *Tagbac*, seu *Bagongbonque*, excipe quod parte prona suavi oblitum sit Lanugine: venosius præterea, longius & suaveolens. Ad Plantæ Radicem seu Caulis Truncum, ex foliacei Caulis Meditullio racemiformis, & Pistillo seu *Amomonti* Florum Fasciculo non adeo similis, prorumpit florifera & grænigera Foliorum susquipalmaris congeries, Flosculis exornata rubicundis, quibus Uvæ in longiusculum protensæ Collum, seu Floris Tubuli Reliquias subsequuntur, dulci & paucò Cortice, unde a Muribus & Avibus una cum semine plerunque depastæ, pauca admodum & exigua colligi potest quantitate. Quare & olim rarum fuisse, nec passim nasci, *Virgilius* insinuare videtur, dum spondet quod, *Assyrium* vulgo nascetur *Amomum*.

Hæ Uva quina communiter, aut sena continent subruffa, oblonga, inæqualia, Aromatica, *Amuyong* minus acria, & *Cubebis* Officinarum suaveolentiora, Grana, seu Acinos; ex quibus trajecto Filo, nunc per se, nunc sociatis Margaritis, ac Corallio, nonnullæ Puellæ *Judicæ Caropi*, seu Monilia ac Armillas, concinnare solent. Aliæ ex his, & semine *Bolmusci*, iis *Maricom*; Arundinis Lithospermos, iis *Tigbi*; Cannæ floridæ, iis *Ticasticas*: Pisi *Coccinei*, iis *Saga*; *Amomonti* præterea, *Badiang*; & *Calanos* Seminibus; similia nectere assueverunt. Ob gratum vero quem spirant Odorem Grana *Tugus* Collo appensa gerunt, ab insecto etiam præservare Aere, & ictui medere *Scolopendriæ*, masticata si super imponantur, experientia docuit. Radix similis est Radici *Tagbac* seu *Calami odorati* insipida, alba interne de foris rubicundis & subodoratis Capaceis contexta obvolucris. Ex *Borongam* scripto accepi, in Caulium apicibus alium & hunc inodorum ferre Fructum, quem necdum vidi. Idem *Indi Indanenses* mihi affirmarunt: sed eos hallucinari censeo, & Plantam *Tacbac* (*Tagbac*) pro *Tugus* vidisse puto.

Provenit in *Borongam* & *Paranas* Caput ex aliis Insularum *Samar*, & *Leyte* locis. Nec dubito in *Luzone* quoque reperiri, maxime *Silani* in Torrentium profunditatibus.

Nota. Florum *Tugus* recentia & tenella Germina, aliquantum *Pseudo Amomum Garcia*, *Pedem Columbinum* referens, exprimunt. Ne autem quidquam desideretur, mitto una cum his scriptis Plantæ Delineationem; & similiorem *Castaneam* esse Ovo non deerit qui objiciat, quam Folia *Tugus* Foliis *Mali Punici*, quod lubens concesserim. Sed quicquid *Dioscorides* & *Plinius* de *Amomo* tradidere, solummodo de florifero & Semine turgente *Tugus* Racemo intelligenda esse censeo: utpote quibus integra & ipsa Planta non innotuit. Hunc enim *Tugus Thyrsus* deprehendet. *B. L.* exigue fruticare *Palmi*, viz. plusve minusve Altitudine. Ex Ligno subruffo, seu lignosa Materia, Flosculis & Folliculis *Mali Punici* similibus, sese in Racemi modum convolvere, sive ut *Barth. Merula* vertit esse Fructum similem *Botruo* inveniet semine Uvis parvis simili, si seminis carnosum spectet Tegumentum plenum valde odorato & acre gustu, vim habente calefaciendi, adstringendi & exsiccandi, & cætera legitimi *Amomi* signa, ut *Pedis Columbini* effigiem si diligenter investigaverit. *Amomum* in *Turcomania*, *Armenia* Provincia, provenire scribit *Joh. Botero Benes*.

The Ahmella from
Ceylon, by
Dr. Horton,
n. 257. p.
365.

XXIX. Nuperis annis magnam celebritatem nacta est, ob vim *Lithontrip-
ticam* quæ ipsi ascribitur, Herba quædam a *Ceylonensibus* *Ahmella* dicta. An
jam uspiam extet nescio, sed eam colui, cum versarer in præfectura Horti
Amstelod. Flores fundit in summis caulibus, persimiles *Chrysanthemo* *Curassau*
elato caule, flo. *Aurantiis* *Par. Bat.* Semen ei bidens, Caules quadrati. Fol. *La-*
mii vel *Urticæ* (quæ subacria sunt) conjugatis amicti; unde manifeste liquet
ad *Cannabinæ* genus, quod bidens vocat *Cisalpinus*, eumque secutus *Tourne-*
fortius, spectare; neque forte inconcinne nuncupari posse *Cannabinam* aut
Bidentem *Urticæ folium* *Judicam* *Lithontrippticam*.

Nux Pepita,
or Faba
S. Ignatii,
by Dr.
Sloan, n.
349. p. 44.
Fig. 163.
n. 150. p. 87.

XXX. 1. *Nux Pepita*, seu *Faba S. Ignatii*, is about the bigness of a Nut-
meg, and triangular. This Fruit is very much esteem'd in the *Philippine*
Islands, for the cure of many Distempers.

2. 1. Habet hic Fructus virtutes illius Metalli quod *Tumbaga* dicimus,
& Compositi illius quod *Ilingo* dicitur; proficit enim contra Spasmos ac Ven-
tos infectos, & contra quoddam genus Spasmi quod nos dicimus *Soran*.

2. Proficit, ut evomatur quodcumque Venenum, si rasuræ ejus bibantur
cum aqua frigida, item contra morsus venenatorum, si simul applicentur
morsui aliquæ rasuræ ejus.

3. Item si aliquod Membrum laboret Spasmo, proficit, si super partem in-
fectam applicentur supradictæ rasuræ.

4. Deinde antedictæ rasuræ stagnant Fluxum Sanguinis, applicatæ cuicun-
que Vulneri. Et cum anno præterito, 1692, daretur bibi Fœminæ laboran-
ti Profluvio Sanguinis diuturno, evasit incolumis.

5. Fugat Febres, nam me præsentē, eodem anno, datum fuit cuidam In-
fantulæ laboranti intensissima Febre, ut biberet, & illico aufugit Febris.

6. Juvat parientes Fœminas, ad hoc ut facilius, & felicius Creaturam ex-
pellant.

7. Venio tandem ad quotidianam experientiam, mire proficit pro quacun-
que Repletionē & Cruditate Stomachi, & contra proficit pro Dysenteria &
frequenti dejiciendi cupiditate temperanda.

Dividat quodque Granum in tres partes, & cum senserit necessitatem, im-
mittat in Os per quadrantem horæ, vel per dimidium, & deglutiat Salivas
quæ distillaverint, ac postea bibat quasi 2 aut 3 uncias Aquæ frigidæ, & vide-
bis effectum.

Aliter; Quærat Fragmentum durissimum testaceum, ac in parte concava
ponatur parum Aquæ frigidæ, & ibi refricetur Fructus, & Aqua illa ponatur
in vascula cum rasuris; & iterum ter aut quater fiat similiter, usque dum
habeas duas uncias illius Confectionis & Lotionis Fragmenti testacei ac grani
fruticis; ac postea revolvatur & bibat Patiens.

Item, Divisum Granum in Frusta, si frigatur cum Oleo, (præcipue *Olivæ*-
rum) & Oleum illud bibatur, aut Plagis applicetur, aut Membra Spasmo labo-
rantia cum eo unguantur, est medicinale ut supra.

3. *Catolengay*, quam alii *Camara* vocant, est, Nuces Vomicae legitimae By P. Geo.
Camelli, ib.
p. 88.
Serapionis ferens, Planta, quæ Arbores quavis altissimas sese involvendo scandit. Truncus lignosus, levis, porosus, & brachialis quandoque crassitudinis, Corticisque scabri, crassi & cinerei: Folia ampla, nervosa, amara, Folio Fig. 164.
 ferme similia: Florem Balauftiæ similem Fructus insequitur Melone major, qui delicatissima Cuticula, quæ splendens, lævis, & Coloris luridi, seu alabastrini, coopertus, subter quam alius Cortex delitescit substantiæ quasi lapidescentis. In hoc Carne amaricante, flava & molli, qualis est Caro Fructus Mangæ, interjecta, nostræ seu legitimæ *Serapionis* Nuces Vomicae, quæ recentes ab argentea Lanugine splendent, Juglandis vix non pares, inæquales, variæque formæ, non raro 24 coarctantur; quas *Indus Igasur*, & *Mananaog*, id est, Victoriosas; *Hispanus Nucleos*, seu *Pepitas de Bysayas*, aut *Cathalogan*, alii *Fabas S. Ignatii* vocant. Hæ resiccatae Avellanae nuce cum putamine pares, aut etiam paulo majores: Nodosæ, durissimæ, diaphanæ, & quasi corneæ substantiæ sunt; Saporis Semine Citri multo intentius amari: Coloris autem inter album & glaucum, prout & *Serapio* tradidit.

Multi, nescio quo oraculo edocti, Nucem *Igasur* reticulæ Fructus *Salagsalag* immittunt, ex Collo suspensum gerunt; & ita ab omni Veneno, Peste, Contagio, Incantationibus magicis, Philtris, specialiter a Sopto, seu Veneno, quod solummodo insufflatum perimere narrant, imo & ab ipso Dæmone se liberos ac immunes esse imaginantur.

Quod *Ch. Miralles* in suis Collectaneis affirmat, scribens non tantum virtutem habere depellendi Corporis Morbos, sed & malignis Spiritibus speciali quadam oppositione resistendi; Magos etenim, *Barangas* dictos, ad præsentiam hujus Nucis inquietari, conturbari, & sudore suffundi, ac si in, nescio quo arduo negotio, angustiis periculisque pleno versarentur: Quod experientia didicisse, insuper & id ipsum sibi alios fide dignos visos affirmasse, addit. Unde pactum cum Dæmone habere dictos *Barangas*, seu maleficos Herbarios suspicatur: præsertim cum rumor ferat, hosce impios Medicos, si in Simplicium cognitione erudiri velint, Consanguineorum proximum interimere obligari.

Alii jam dicto Sopto, seu Toxicæ Insufflamine, quo malevoli *Indi* passim quos male cupiunt perimunt. *Alexium Lopez* in *Guiguan*, & *Petrum Oriol*, præter alios hacce Nuce præmunitos, servatos fuisse ferunt. Sumunt autem, uti vulgus narrat, supradicti Herbarii eis familiaria & nota Aconita, quæ faucium latere uno recondunt, bucca altera vero *Contrayerbas*, prouti hujates loquuntur, id est Antidota, ne videlicet sibimet ipsis mortem mastitent. His ita ore detentis arte, & dexteritate diabolica, sibi contrarios, & inferos Viperae more intoxicato halitu impetunt, quo perculsi ac perplexi mox humi prosternuntur, & animam agerent, nisi eis jam experto remedio hacce *seil.* Nuce opem ferant. Addunt, si quis hanc Nucem secum portarit, ipsum qui similibus deleteriis buccellis alterum interficere attentaverat, pœnas confestim luere Talionis, uti *Indus*, qui *Alexium Lopez* inter fictas amicitias de medio tollere cupiens, casualiter hanc Nucem secum habentem expertus fuit, quæ occasione primum *Hispanis* innotuit *Igasur* virtus & efficacia. Quomodo autem

tem naturaliter, ut nonnulli volunt, *Igasur* virtutem Toxici in distans agendo repellat, iudicent alii.

Pulveris *Igasur* ʒ i. quondam *Vincentio Olzina*, temperamenti melancholici prædito, ad Vomitum ciendum propinavi. Hic Dyspepsia, Diarrhæa, et frequenti Vomitu, cum Ructibus acidis, necnon flatuum copia molestabatur: Sed statim ac sumpsisset, tremore totius corporis trium horarum spatio persistente, una cum Pruritu, et Vellicationibus convulsivis horrendis, ut pedibus insistere nequiverit, quæ in Maxillis vehementiores erant, ac magis molestæ, ita ut quodammodo ridere cogeretur, correptus fuit; nulla interim notabili Pulsus alteratione, Vomitu, aut alio quopiam insequente Symptomate. De reliquo dein non nihilum melius sensit.

Similem tremorem, et Convulsiones spasmodicas, quas *V. Olzina* expertus fuit, sensit et passus est *Johannes Osaeta*, una cum summa Præcordiorum angustia, Vertigine, Animi Deliquio, et Sudoribus frigidissimis. Hic Melancholico-Hypochondriacus Sanitatis cupidus, Nucem recentem integram devoraverat. Cui Oxymel et Oleum cum tepida exhibendo, quo plurimum viscosi Phlegmatis cum Nucis particulis rejicit, opem tuli.

Joachinus Assim Nucis sumpserat partem tertiam, et simili modo ut *V. Olzina* & *Johannes Osaeta*, ultra tres horas affectus fuit. Hic præter Motus contractivos et involuntarios, fornicationis sensum, et specialiter in capite expertus fuit similes denique pœnas. *A. Varaona*, *A. Girau*, et alii luere.

Vulgus autem Nucem *Igasur*, ad cuncta absolute corporis humani mala amovenda, nulla habita Temporis, Morbi, Ætatis aut Dosis ratione, indifferenter exhibet et adhibet: Miraculosque subsecutos affectus narrat, videlicet magnificiendo suam Panacæam, et deprædicat successus bonos, reticens infaustos. Nec dubium, quin aliquando a tam vehementi spirituum animalium irritatione, ac alteratione Humorum, ab hac Nuce causata, heterogenea ac incongrua, una cum tam infesti Medicamenti Particulis eliminentur: quibus rejectis, humoribusque crassi meliori restitutis, sanitas optata subsequatur.

Modus ordinarius et communis utendi Nuce *Igasur* est, imponendo eam integram aquæ calidæ tantillo spatio donec amara reddatur, exhibendo dein dictam Infusionem. Alii Pulveris modicum in substantia propinant. Alii unam alteramve offerunt deglutiendam frustulam. Alii Nucem integram, Amuleti ritu, de Collo suspensam gerunt.

Vomitum pluries causare solet, Dejectiones nonnunquam; Motus Spasmodico-Convulsivos ferme semper in *Hispanis*, *Indis* non. In Veneni periculo, et Spirituum inordinate tumultuantium conflictu, posthabita temporis ratione usurpanda erit: In aliis accidentibus aut Morbis jejuno Ventriculo in Aurora; attamen Vomitus ciendi gratia convenientius una alterave post assumptum cibum Rora, Dosi ʒ ss. cum aliis levioribus Vomitus cientibus exhibetur.

Qui Nucem integram secum portarint, affirmant multi (fides sit penes Auctores) præservare a Peste, Incantationibus magicis, Philtris, Sopto, seu Herbarum

barum venenatarum afflatu, Aeris præterea, nescio quo ut volunt, Contagio, *Hispanis*, Malaire, & Pasmo, id est Stupore, *Indis Sautan* (a quo similiter præservare ferunt Corallium nigrum, Ungulam Rhinocerotis, Dumbagam, Ingo, & Testudinis Scutum ;) Catalepseos attamen Species potius esse videtur, eo etenim correpti terrore veluti panico perculsi corruunt, sensibus & voce privati obstupefcunt, mortuisve sæpius similes obrigescunt ; revulsoria vero, & crudeli Musculorum in Tibiis, ac Brachiis flagellatione, qua Sanguis inihi aggestus dein Scarificationibus elicitur, revocantur & curantur.

Nucis frustulum, aut fragmentum, aut rasuræ modicum, *Viperæ Basul* (est *Eruca*, pilosæ atque nociferæ, ad tactum vehementem pruriginem causantis, Species) aut aliorum venenatorum Animalium morsui ; Vulneri sagitta vel alio intoxicato telo facta, ad impositum, venenum lapidis colubrini instar adhærendo extrahere communicavit *F. de la Zarza*. Alii in Hæmorrhagia Narium, & ad Sanguinem e Vulneribus profluentem sistendum, pulverem recommendant.

In Malviento, Malaire, Sautan, & Pasmo, (Catalepseos Species est) Stupore, Apoplexia, Paralyfi, five Syderatione, Lethargo, Epilepsia, Morbo caduco, Asthmate, & Catarrho maligno ac suffocante, Dentium dolore, & aliis defluxionibus, frustellum supponitur linguæ, apophlegmatizandi gratia : ita enim caput a copia viscosi Phlegmatis liberatum, ægri pluries levamen percipiunt, & sæpius jamjam agonizantes, ut ita dicam, resuscitentur, & aut confiteri, aut alia quæ pro tunc conveniunt, declarare, valent.

Pulverem, aut infusum, aut oleum infra descriptum, propinant & dilaudant in Febri tertiana & quartana. Veneni periculo, aut supradicto Sopto, *Buyasso*, (est *Buyo*, seu *Betele*) confectio mortifera, cum semine ut opinor *Stramonii*, aut simili narcotico, quæ si assumptæ non perimit, Hominem perplexum, attonitum, hebetem, stupidum, & torpidissimum reddit ; ab hujuscemodi dico confectioe devorata, aut masticata, infra posito oleo curata fuisse scio, & *Botete Sardinæ* nocivæ comestæ suspicione.

Ad Urinas item, Menses & Puerperia suppressa provocanda, Partum difficilem facilitandum, Secundinam, Fætum mortuum & Lumbricos expellendos, efficacem reperi. In Dolore cholico præterea, cibi indigestione, cruditate Ventriculi & concoctione læsa, Diarrhæa, Tenesmo, & obstructione Epatis, ac Lienis, uti & in omnibus supra enumeratis Morbis, exhibent.

Oleum vero ex *Igasur* simpliciter infusione paratum emeticum est efficacissimum ; valet ad eadem ad quæ *Nux ipsa* ; hoc ad *Magi Barang* præsentiam effervesce, & vase quo asservatur exilire, vir retulit fide dignissimus. Idem & alii in suis scriptis affirmant.

Hoc Oleum alii efficacius reddere cupientes componunt, ex *Igasur*, *Tambal de Garigara*, *Tambal de Sangil*, *Tambal de Bornei*, *Salagsalag*, *Camaesa*, *Manungal*, *Alagao*, *Salibutbut*, *Tambalisay*, *Marbar Molavin*, *Borogtongon*, *Palayacan Panambuc*, *Pancoro*, *Nolalasson*, *Bagatapon*, *Oringun*, & aliis ; vulgo *Jazeite de Tambal*, a Cortice scil. emetico *Mananangtang*, appellatur, violenter purgat, per superiora, & inferiora ; Dosis $\frac{3}{4}$ i. $\frac{3}{4}$ ii.

Lignum sanctum Luzonis Quajaco utiliter substituitur ; de reliquo Concoctionem

coctionem adjuvat, & dejectam ciborum excitat appetentiam. N. B. Prægnantibus exhiberi non potest, quin Abortum patiantur.

Lignum Colubrinum Manungal, Decoctum ejus, Venenis omnibus, venenatorumque Animalium morsibus, succurrit; Febrifugum est, & Anti-Asthmaticum, Obstructiones inveteratas referans, & abjectam ciborum restaurans appetentiam; Ictero præterea, octo dierum spatio in aurora haustum medetur. Lumbricos pellit, & cholicos Dolores mitigat. Decoctum ex $\frac{3}{4}$ ii. paratum, dejectiones ferme quinas causare solet.

Cortex Vomitorius Mananangtang, datur in pulvere a $\mathfrak{D}$ i. ad $\mathfrak{D}$ iv. Pituitosa & lenta, nec non biliosa, per Vomitum & Seceßum potenter evacuat; Unde in Febris, ventriculi repletionem aut ex humoris viscosi turgescencia, Cachexia & Hydrope, feliciter exhibetur. In omni Veneni periculo, decoctio *Manungal*, & ad Ventris Lumbricos educendos, plurimum facit.

By Dr. Horton, n. 257.
P. 365.

4. Novissime increbuit usus Fabæ, quam vocant, *di S. Ignatio*; dicitur & *Isasur*, & *Faba di S. Nicholas*, & de *Cava Longa*. Semen est amarissimum, quod nullam Fabæ præ se fert similitudinem, ut ex ipso Semine videbis. Ad movendos Sudores & debellandos Febres præcipuum creditur: & Diarrhææ, Dysentericæ, cholici Doloribus, Motibus Convulsivis, ipsique Epilepsiæ mederi; & externe admotum, Scabiei; celebratur cum primis & ejus Virtus Alexipharmica. Provenit in *Philippinis*, quas vocant, iisque vicinis, Insulis. Cujus Generis Stirps sit ignoratur; id tantum didici ex *D. Rafaele de Roa Hispano*, Viro egregio & erudito, qui in iis Insulis diu vixit, convolvulaceam esse Plantam Arbores altissimas scandentem, fructumque ferre Mali Punici magnitudine, quo complura Semina reconduntur, ex quibus deciduis novæ Plantæ subnascuntur.

Cherries recovered, tho almost wither'd, by Dr. Chr. Merret. n. 25. P. 455.

XXXI. I had three *May Cherry-Trees*, planted in a rich Mould, which lay to a South Wall, shaded from the Sun by a high Building, till the beginning of *March*; when being high, and shining somewhat fiercely upon them, the Fruit constantly wither'd. But this Year, 1665, the Season being very hot and dry, I barred the Roots of one of them, by making a hole about it, and watered it every Morning and Evening with about a Gallon of Water, for about a Fortnight before the Cherries came to Redness; and the Fruit was full and good. The other two Trees, left without this ordering, had most of their Fruit wither'd, having only Skins and Stones. Then I made a Hole round about one of the other Trees, and fed it with Water daily, as the former: In a Week's time, those that were quite wither'd fell off, and the rest that were not so, grew and increased exceedingly; the other Tree, that was not used after this manner, had not any of its Fruit come to Perfection.

The Sorbus Pyriformis; By Mr. Edm. Pitt. n. 139. P. 978.

XXXII. I have lately found the *Sorbus Pyriformis* of *Lobelius*, or *Sorbus Procera* of *Bauhinus*, growing wild in a Forest of *Worcestershire*. It resembles the *Ornus* or *Quicken Tree*; only the *Ornus* bears the Flower and Fruit at the End, this on the sides of the Branch: Next the Sun, the Fruit hath a dark red Blush;

Blush; and is about the bigness of a small *Juneting Pear*. In *Sept.* it is so rough as to be ready to strangle one: But being then gathered, and kept till *October*, they eat as well as any *Medlar*.

2. Perhaps a *Verjuice* made of this Fruit, either ground with Crabs, or *By-----ib.* Grapes, or if plentiful, alone, would, being kept for some time, prove one *P. 279.* of the best *Acid-Astringent Sauces*, that Nature affords.

XXXIII. The last Autumn I met with a double Pear, one part growing over, and being fixt in the other; not unlike an Acorn in its Cup: From the Edges of the lower Pear there grew up 5 Leaves of various Magnitude, at distances almost equal from each other. The largest of them was one Inch long, half an Inch broad; as large again as the smallest Leaf. These Leaves grow out of the Skin of the lower Pear, and had no Fibres rising from the carnous part of it. One of the Leaves, the largest of them, had a Fibre of the bigness of a small Hair, continued from the place where the Leaf rises down, just within the Skin and loose from it, to the *Pedunculus*. The outer Coat of the *Pedunculus* was continued to the Skin of the lower Pear, and this Skin to that of the upper Pear. The inner Fibres of the *Pedunculus* go thro the lower up into the upper Pear, and disperse themselves in it. The upper Part was twice as big as the lower, and had several Kernels in it, but the lower none at all.

XXXIV. I have planted here (in *Virginia*) 10000 *Mulberry-Trees*; and hope within 2 or 3 Years, to reap good Silk off them. I have planted them in a way unusual here, which advances them two or three Years growth, in respect of their being sown in Seed. I intend likewise to plant them all, as if they were *Currants* or *Goose-berries*, so thick as Hedges. By this way of planting them in Hedges they will be always young tender Plants; and consequently will be easily cut in great quantities with a pair of Garden Scissars; whereby one Man may gather as many of them, as otherwise, when they are planted in Trees at distance, 4 Persons can do. But perhaps it may be a better way to sow some Acres with *Mulberry-Seed*, and to cut it with a Scythe, and ever to keep it under.

XXXV. The vulgar Husbandman (without the Expences, Curiosity, Care, or Trouble of grafting) may propagate the *Genet Moyles* by the knotted Branches alone, in Ground that deserves not to be call'd fertile; as they do in the *Rye-Land*, and *Gorsty Ground* in *Wales*: and the Cyder made of the Fruit, which, when perfectly ripe, hath a peculiar Fragrancy, is delicately agreeable to tender Palates, till the heat of *July* does too often alter the Case.

There is a Summer Apple call'd *French Cornel*, early ripe, and very richly full of a most pleasing Liquor, which I dare extol for a most delicious Beverage before the ordinary time for Cyder comes in. 'Tis a small Tree, all the Branches crisped, and curled full of Knots at every turning, and apt to grow by any Branch that is cut off below the Knot. It prospers best in a good

A double Pear, by n. 260. p. 470.

An unusual way of propagating Mulberry-Trees, in Virginia, for the Silk Work; By-----n. 12. p. 201.

Choice of Fruit Trees for speedy Propagation and pleasant Liquor; By Dr. J. Beal. n. 71. p. 2146.

good Mould better than that of the common Field ; yet in the dry Ryeland it bears plentifully every second Year, and when one of these Trees fails, the next of the same kind may have a full Burden.

Some Soil which doth hardly bear Apples, does most kindly bear Pears ; and there is a great variety of Pears to humour every Palate. In the Confinies between *Worcester* and *Hereford*, from *Powick* to *Bosbury*, the *Bare-land-Pear* grows in the common arable Field. That, and some other Pears of uncertain Names, in *Powick* do yield a very strong and long lasting Liquor. The *Horse Pears*, as there they call them, the white and red of several kinds, yield abundance of pleasant Liquor. The *Ailets*, great and little, wild and gentle, the *Linton-Pear*, *Lullam-Pear*, *Squash-Pear*, have their peculiar Excellencies for Liquor, and some of them for the largeness of the Tree ; yielding constantly some Hogshheads of Liquor yearly.

Where the Soil hath not been try'd and found kindest for Apples, 'tis the surest way to plant Pears alternatively ; and where the Liquor of Pears is weak, or less lasting, this may be helped by a gentle mixture of Crabs, or of the hardest Apples to humour all Palates, and for a help to the Stomach, the Mixture being made in the time of grinding the Fruit together. And thus, when the better Soil is too shallow for Apples, but receives Pears kindly at a greater depth, a Hedge-row of Crabs, or wild austere Apples, raised on the Mounds, and ripening in the same Season, will by well ordering it, afford such a perfect Remedy, that judicious Palates may be deceived, and take it for the best Cyder. Sir *W. S.* recommends the *Hamlin-Apple* of *Devon* for Cyder equal to the best, if not excelling.

An easy
way of raising
Fruit
Trees, by
Mr. Lewis,
n. 95. p.
6067.

XXXVI. Take a piece of the Root of any Apple-tree or Pear-tree, &c. about 6 Inches long, and Tongue-graft a Graft of an Apple or Pear into the Root. The way of Tongue-grafting is, to cut the Root sloping about one Inch, and the Graft sloping in like manner one Inch ; cutting both very smooth : Then cleave the Root and the Graft likewise about one Inch, and enter them into one another, that the Sap of the Graft may join to the Sap of the Root, as much as you can. Lap the jointed place about with a little Hemp or Flax-hurds ; set the Root so grafted into the Ground about 10 or 12 Inches deep, so as the Joint may be covered at least four Inches under the Earth, that it may not be bared at any time, but kept moist by the Earth.

The Root you graft upon, must not be less than your Graft ; it is no Inconvenience if it is bigger : But it is best that the Root and the Graft be of the same bigness.

About 29 Years since I sowed a Bed of Apple-Kernels in *March*, the Spring following I plucked up 40 of those Seedlings, grown to the thickness of a fair Graft ; I grafted them in this manner of Tongue-grafting, and planted them again. They all grew, and 4 of them bore Fruit to Perfection that Year ; so that in a Year and half, from an Apple-Kernel I had ripe Fruit. Some of these Trees will now bear 2 Quarters of Apples upon a Tree ; and are bigger than most

most of those Trees amongst which they stand, which cost 12 *d.* the Tree when these were Kernels.

I conceive that Plumbs, Cherries, Apricocks, Peaches, and all sorts of Fruit-Trees may be thus raised.

XXXVII. 1. I never begin to plant till *Valentine's Day*; and I approve of late planting before early; the Cold in the Winter kills more than the Drought in Summer. We impute it indeed to the Drought, because they languish until Summer, and then die: But they receive the fatal Stroke by the Cold in Winter.

The best season of transplanting, by Mr. R. Reed, n. 70. p. 130.

For either we take our Stocks out of Woods, or out of Nurseries; in either Place they lie warm, and if you transplant them in *October*, you expose 'em on a sudden to an open Air, and adventure them, being weak, to a long and perhaps cold Winter, which they cannot bear. Add hereunto, that I can relieve them against the Drought, by watering and covering the Ground, to keep it cool: But there is no Fence against the Frost, which many times gets into the Roots, and kills, so that they never spring; or if they do, yet pulingly, and die in the Spring; or if they survive, as many do, yet come on very slowly and pitifully. For the Bark does cleave to the Wood by reason of the Cold, which dries and clings them together, that, like a Hide-bound Horse, they will not admit the Sap which the Root would send up; and other Suckers grow out of the Earth; and the Tree grows dry, and turns red: All which discovers the Obstruction in the receiving the Sap, which would come from the Root, and then we are forced to score and loosen the Bark, as we can. Now on the other side, if the Summer proves moist, the Danger and Fear of late setting is over, and they will thrive and come forward amain; if otherwise, I seldom see but they always keep green and fresh, being maintained in Life and Verdure by the Sap they receive in the beginning of the Spring, before they be transplanted.

This therefore I do (which I submit to better Judgments and Experience;) In the dead of Winter, I prune and cut the Tree I intend to transplant, as I would have it be, to the end to lose nothing of its Strength when I transplant. Then I suffer it to abide untouched by the Spade till *Valentine's Day*, and then remove it after it hath taken in somewhat of the Spring. I am very careful to preserve and set the Roots as large as I may; supposing the larger Root, the more Strength and Sap it contains, and so will advance the more the growth of the Tree; since every thing grows in proportion to the Root beneath. But I have heard from some Planters, who had Experience therein, that Roots cut short do best, as sending forth new Roots, which draw Sap and Nourishment best. And we see that *Moyles* set on Slips, that have no Roots, come to a Tree soonest; and I have oft observed, that a *Moyle* transplanted after it hath taken Root, does not live so certainly, or thrive so well, as a Slip newly set.

2. Dr. *Lauremberg*, a Person of much Experience, agreeth with Mr. *Reed*, *By Dr. J. Beal, n. 71. p. 2143.* that Plants which cannot well bear the hardship of the Winter, should be transplanted.

Lauremb. de
Hort. Cult.
l. 1. c. 28.

transplanted in the Spring ; but that such as are able to bear the Extremity of a cold Winter, should be transplanted in Autumn. In this only he differs, that he saith, *Poma, Pyra, Cerasa vulgaria, Coryli, Oxyacanthi, Pruna, &c. facile Frigus ferunt, & Autumno transplantari optimo successu solent* ; and then for the Spring, he refers *Juglandes, Persica, Abricoca, aliquot Cerasorum genus*. And I think, where he wrote and practised, it is as cold a Country as *England*. I shall only add, that 'tis an old *English* and *Welsh* Proverb, concerning Apples, Pears, and the Hawthorn Quick, Oaks, &c. *Set them at Allhallontide, and command them to prosper ; set them after Candlemas, and intreat them to grow*.

Blossoms do
not forth-
with disco-
ver a Blast,
by Dr. Beal.
n. 23. p.
424.

XXXVIII. It is to be noted, that the Blossoms of Fruit-trees do not forthwith discover the Blast ; for an old experienced Country-man having once given me notice of a blasty Noon, (it being then sultry Weather and somewhat gloomy with the Thickness of Exhalations, almost like a very thick Mist) within a Day or two after shew'd the Proof upon the Cherry-blossoms, then flagging, but not much altering their Colour till two Days more were past.

Cyder, by
Mr. R. Reed.
n. 70. p.
2128.

XXXIX. 1. I do commend for the advancing of Cyder in Richness, both for Taste and Colour, a new Cask, provided it be made of Timber very well seasoned ; otherwise it may spoil it utterly. I have often tried it, and found that sort of Cask to improve the Cyder.

The best Cyder I ever had, was Redstreak grafted upon a Gennet Moylestock. For, as those kinds do best agree, and the Trees so grafted seldom canker, (as do the old Redstreak upon a Crab-stock) so the Fruit is far more ingenious and milder ; and being ripe, both rich and large, and good to eat ; and the Cyder is more smooth, and abates in Strength and Harshness of that on the Crab ; and needs less of mellowing before making ; the Stock in degree altering and reclaiming the nature of the Fruit. For, as an Apple doth best grafted on a Crab, which gives Acrimony and Quickness to the Fruit, so a Crab (and a Redstreak is no other) grafted on an Apple, receiveth thence Gentleness and Softness, and Largeness, and an excellent Alloy to the Sharpness, and (as Mr. *Evelin* calls it) the Wickedness of the Fruit.

An excellent
Drink from
Apples and
Mulberries,
by Mr. Sa n.
Colprets, n.
27. p. 501.

2. A Composition of the Juices of good Cyder-Apples and Mulberries produceth the best tasted and most curiously coloured Liqueur, that many ever saw or tasted.

Vines, by Mr.
J. Templer,
n. 93. p.
6016.

XL. I have lately seen a pretty and pleasant Culture of Vines, at the House of a Gentleman, who makes very good *White-Wine* of his own Grapes. He lets Vines ascend by one single Stem to the Eaves of his House (cutting off all the luxuriant Branches by the way) then gives them liberty to spread upon the Tiles, all over one side of the Roof of his House. Thus he furnishes his Dwelling-House, and many Out-houses ; by which means the Vines are no hindrance to his other Wall-Fruit, and the Rays of the Sun being almost di-

direct upon the Vines, he hath riper, sweeter and greater plenty of Grapes, than when their Vines are placed as Wall-Fruit.

XLI. At *Frontignac*, they let the Grapes grow half dry upon the Vine, and as soon as they are gathered, they tread and press them immediately, and turn up the Liquor, without letting it stand and work in the Fat, the Lee causing its goodness. Thus is made the true genuine Muscadine, without mixing any other sort of Grape with it. Lately a certain Person thought fit to pass White-Wine of another kind upon the Husks (which are wont to be cast away) of the Muscadine Grapes: And hath made in this manner an excellent Wine, which hath the Taste of Muscadine, and is more pleasing to some, nor is so heady, as the franc or true Muscadine.

To make
Muscadine
Wine; By
M. de Mar-
tel, n. 58. p.
1183.

XLII. They take two great Casks, within each of which they put at the bottom a Trevet, which must be one Foot high, and as large as the largeness of the Cask permits. Upon this Trevet they put Vine-Twigs; whereon they lay a substance called Rape, with which they fill both Vessels, within half a Foot from the Top. This Rape is nothing else but the Wood or Stalks of the clusters of Grapes dried and freed from the Grapes. The Trevet and the Vine-Branches are put at the bottom of the Casks, only to keep the Rape from the settling at bottom. It is this Rape which alone heats and fours the Wine. The two Vessels being almost quite fill'd with the Rape, one of them is fill'd up with Wine, and the other only half full for the time; and every day they draw by a Cock half the Wine that is in the full Vessel, therewith quite to fill up the other that is but half full; observing interchangeable turns of filling and unfilling the Vessels. Ordinarily, at the end of 2 or 3 Days, the half-fill'd Vessel begins to heat, and this Heat augments for several Days successively, continuing to do so till the Vinegar is perfectly made; and the Workmen know, that the Vinegar is made by the ceasing of the Heat. In Summer it is a Work of 15 Days: In Winter it proceeds more slowly; and that according to the degree of Cold Weather.

The way of
making
Vinegar in
France; By
M. —. n.
61. p. 2002.

When the Weather is hottest, the Wine must be drawn twice a Day, to put it out of one Vessel into the other. It is only the half fill'd Cask that heats, and as soon as you have done filling up, its Heat is choaked and stopped for the time, and the other Cask, which is unfill'd, begins to heat.

The full Vessel is quite open at the top; but a wooden Cover is put on the Vessel that is but half-full.

The best Wine makes the best Vinegar; but yet they make good Vinegar of Wine that is turned.

The Wine in changing leaves a certain Grease, which sticks partly to the sides of the Cask (and that they take care to do clean away) and partly to the Rape; so that if they cleanse not the Rape from it, almost every Year once, the Wine turns into a whitish Liquor, which is neither Wine nor Vinegar.

Vol. II.

P P P P

At

At the time when they pour the Wine out of one Vessel into another, Scum ariseth on the top of the Vessel, which must be taken carefully away.

In the Casks, which have never served for this purpose before, the Vinegar is made more slowly, than in such as have been used already.

ib. p. 200. The Rape, as soon as 'tis separated from the Grapes, (which is done immediately after Vintage) is carefully put up in Barrels, lest it take Air; without which it would heat it self and be spoiled.

There is no other way of keeping the Rape that hath once served already, than to drown it; that is to say, to fill the Vessel wherein it is with Wine or Vinegar. Rape will serve a Year, more or less, provided care be taken of cleaning every Morning, with a piece of Linen, the Grease that is on the sides of the Vessel; and with a little Broom, that which swims on the top of the Liquor. The Rape may be freed from its Grease with Water, rubbing it between ones Hands. No body that I know hath hitherto examin'd what this Grease is.

I have been lately informed, that there have been Merchants here, who made Vinegar with Phlegm of Wine, remaining after the *Aqua Vita* is extracted from it.

*Orange-Trees; By--
n. 29. p. 554.*

XLIII. A Provincial at *Paris* pretends to keep Orange-Trees in that Town all the Winter long without any Fire, tho they remain in the Earth, and not be put in Cases or Boxes. This is thought to be effected by a peculiar sort of Dung used for that purpose, and wrought deep into the Ground.

*One individual Fruit
half Orange
and half
Lemon;
n. 29. p. 453.
By Mr. --ib.*

XLIV. We have Orange-Trees at *Florence* that bear a Fruit which is Citron on one side, and Orange on the other. They have not been brought hither out of other Countries, and they are now much propagated by Engrafting.

2. A very ingenious *English* Gentleman asserts that himself not only had seen but bought of them *An. 1660.* in *Paris*, whither they had been sent by *Genoa* Merchants; and that on some Trees he had found an Orange on one Branch, and a Lemon on another Branch, as also (consonant to the *Florentine* Information) one and the same Fruit half Orange and half Lemon; and sometimes three quarters of one kind, and one of the other.

*By Pet. Na-
rus. n. 114.
p. 313.*

3. About 30 Years since a Tree was first met with in a Grove near *Florence* having an Orange Stock, which it seems was so grafted upon, that thence it became in its Branches, Leaves, Flowers and Fruit, three-formed; some emulating Orange, some Lemons or Citrons, some partaking of both Forms in one. And particularly as to the Fruit, some of this Tree are meer Oranges, yet some of them of an oblong Shape like Lemons, some round like common Oranges, some between both: Others taste like genuine Oranges, others have an Orange Shell, but a Lemon Pulp. Most are of a very strong Scent, and a Shell of a very bitter Taste. But then the same Tree bears also a kind of Citron-Lemon, yet not so many as of the former kind. And not only so, but it produces also a Fruit, that is in one both Lemon, Citron, and Orange; so as you may see outwardly two sorts of Fruit represented in one Piece; one, Citron-Lemon, the other Orange. But this Fruit is so diversified, that some of them are half Citron-Lemon, half Orange; others have Two-thirds of Citron-Lemon

Lemon and one of Orange, others the contrary: And of all these, some are oblong, some round, some bunchy, some smooth, some rugged, some small, some of the bigness of two Pound Weight. Their Flesh is so distinguish'd, that where the Orange Pulp ends, that of Lemon begins, and on the contrary. Again, the Orange Pulp is narrower than that of Lemon; but this is tenderer than that, not so agreeable to the Taste, as the genuine single Fruit. They have either none, or very few, or empty Seeds: Nature, it seems, since this Tree is of the Insititious Kind, nor can be repaired or propagated by Seed, is not at all solicitous in the Generation of them.

The first Original of this Tree was by inoculating Orange upon a Citron-Lemon-Stock, so that by the Marriage of these Trees, repeated for many Years, it was come to pass, that by the closeness of the Inoculation, whereby in length of time the mixed Nature of both Trees was grown together, which the different Juices, permeating the common Fibres, had for a long time nourished, there emerged at length a *Germen* or Graft, perfectly retaining the Nature and Species of both; into whose different Branches when sometimes one, sometimes both kinds of Juices did pass, it produced on one of those Branches a meer Orange, on another a Citron-Lemon, on a third a Citron-Lemon-Orange, and even sometimes upon one and the same Branch, all the three sorts of this Fruit together.

XLV. Mr. *Edw. Clyve* (and he is the first) who brought a dry'd Branch of the Coffee-Shrub AA. from *Mecha* in *Arabia-Felix*, gives this account of it. This Branch was taken off a Tree 7 or 8 Foot high, is about 5 Foot long, and covered with a grey almost smooth Bark. The Wood is white, and the Pith not very large, the Twigs are covered with a dark-colour'd very smooth Bark, and rise opposite to one another by pairs, standing cross to one another, coming out of opposite sides of the Branch, or the two Pairs next to one another, cutting each other at Right Angles. After the same manner stand the Leaves on the Twigs, as the Twigs on the Branches, at sometimes an Inch, and sometimes two Inches distance, each pair of Leaves from the other one. The Leaves have $\frac{1}{2}$ Inch Foot-Stalks, being about four Inches long, and two broad in the middle where broadest; whence they decrease to both Extremes, ending in a Point. They are smooth, whole, and without any Incisures on their Edges, somewhat like the Leaves of a Bay. The Fruit comes *ex Alis Foliorum*; hanging or sticking to the Twig by $\frac{1}{4}$ Inch long Strings or Foot-Stalks; and sometimes one, two or more, at the same place.

These Shrubs are planted in *Arabia-Felix*, call'd *Jaman*, every where in a rich Ground or Mould, in great Plenty, and are watered in times of Drought as other cultivated Vegetables there, by artificial Channels from Rivers cut on purpose to nourish them; and after three, four, or more Years bearing, the Inhabitants are forced to plant new Shrubs, because the old ones become not so fruitful after that time. They dry them in the Sun, and afterwards take off the outward Husk of the Berries by means of Hand-Mills,

An Account of the Coffee-Shrub; By Dr. H. Sloan; n. 208. p. 63.

Fig. 165.

as they do here the Husks of several sorts of Grain, to fit them for use: And the *Arabians*, in Summer Heats, use these Husks, roasted after the manner of Coffee-Berries, esteeming that Drink more cooling, it being sourish to the Taste.

Explication
of the Fi-
gures.

A. A. Represents the Shrub, wherein is observable the manner of its Branching, and of the growing of the Leaves and Fruit.

a a a a. The Fruit, growing 2, 3, or more at a place on the Twigs.

B. One of the Leaves, of its natural bigness.

C. The Fruit, of the true Size and Figure.

c. The Fruit, with the Husk on.

e. The Fruit, with the outward Husk taken off.

i. i. The Berry, with both Husks taken off.

An Ac-
count of
Coffee; B
Mr. J.
Houghton,
n. 256. p. 311.

XLVI. I cannot learn the use of any part of the Coffee-Shrub, except the Berries; of which, boiled in Water, a Drink is made, and drunk much among the *Arabians* and *Turks*. Perhaps 'twas their *Succedaneum* for Wine, which *Mahomet* had prohibited: For by its actual Heat it refreshes the weary, and does several other Services, as Wine that acts by a potential Heat.

It has not been in use (as Mr. *Tavernier* tells us) much above 120 Years. However the use of it quickly became general, and that made it a Trade in great Towns. Into the publick Coffee-Houses they would come by hundreds, and among them Strangers would venture, where they learned the Custom, and carried it into their own Countries. One Mr. *Rastall*, an *English* Merchant, whom I knew, found a Coffee-House at *Leghorn* in 1651. The next Year Mr. *Dan. Edwards*, a Merchant from *Smyrna*, brought into *England* a *Greek* Servant, call'd *Pasqua*, to make his Coffee: So that 'tis likely that this Merchant was the first who used it in *England*, (tho I am informed that the famous Dr. *Harvey* did frequently use it) as his Servant *Pasqua*, whom he thought fit to set up, was the first Coffee-man.

The best Coffee-Berry is what is large and plump, with a greenish cast, and having on the thin parts a Transparency; the other has a yellowish Cast, and is more opaque; but when they are roasted, 'tis hard to distinguish.

I put some Berries into a Glass of Water about a Week since, to see if they will sprout; but as yet there is no appearance, altho they are tolerably swell'd, and look white and bright.

I have made a Decoction of them, which has made them shoot.

The common way of preparing the Berry for the Drink-Coffee, is roasting it in a Tin-Cylindrical Box full of Holes, thro the middle of which runs a Spit; under this is a semicircular Hearth, wherein is made a large Charcoal-Fire: By the help of a Jack, the Spit turns swift, and so it roasts, being now and then taken up to be shaken. When the Oil arises, and it's grown of a dark-brown Colour, it's emptied into two Receivers, made with large Hoops, whose bottoms are Iron Plates, these shut into: and there the Coffee is well shaken, and left till almost cold, and if it looks bright, oily, and shining, 'tis a sign 'tis well done.

Of this, when fresh, if an Ounce be ground, and boiled in something more

more than a Quart of Water, till it be fully impregnated with the fine Particles of the Coffee, and the rest is grown so ponderous, that it will subside, and leave the Liquor clear and of a reddish Colour, it will make about a Quart of very good Coffee.

The best way of keeping the Berries when roasted, is in some warm Place, where it may not be suffered to imbibe any Moisture, which will pall it, and take off its Briskness of Taste. 'Tis best to grind it as used; except it be ramm'd into a Tin-pot, well covered and kept dry, and then I believe it will keep good a Month.

There will swim upon the Coffee an Oil, which the *Turkish* great Coffee-Drinkers will take in great Plenty, if they can get it. When the Coffee has stood some time to cool, the gross Parts will subside, the Briskness will be gone, and it will grow flat, and almost clear again.

I sent to the Chymist 1 Pound of clean Coffee, 1 Pound of husked Horse-Beans, and 1 Pound of pick'd Wheat; and I received back,

<i>Coffee.</i>				<i>Horse-beans.</i>				<i>Wheat.</i>		
	3	3	9	3	3	9	gr.	3	3	9
<i>Spirit net.</i>	VI.	VI.	o	VI.	I.	o	XII.	VIII.	II.	I.
<i>Oil</i>	II.	IV.	II.	I.	III.	o	X.	I.	o.	gr. VI.
<i>Cap. Mort.</i>	V.	III.	o.	V.	III.	o	o.	IV.	VI.	

By this Account it appears, that Coffee yields by Distillation in a Retort almost double as much Oil as Beans, and almost treble as much as Wheat.

The Oils are very thick, but they and the Spirits have all of them ill Savours, as is usual from burnt Materials.

By Spirit is meant the Phlegm.

The *Capita mortua* have no Smell. They have been calcin'd over and over, with all the Art my Chymist has; but he cannot reduce them to a Calx or Ashes, and concludes there is no Salt to be gotten from them.

From what is said, I note, that from the common Drink called Coffee, there is little good can come from any part but its Oil, because its other thin Parts are evaporated, and its thick subsides; but its Oil I suppose to be nutritive *quasi* an Oil, and warm *quasi* a Chymical Oil, for all the warm parts are brought hither as to a Point, and thereby it may enliven and invigorate some heavy Parts in the fermentative Juices, and nourish weak Parts within, as other Chymical Oils do the Parts external when rubb'd, but being dilated, as it usually is, I question whether it does any more good than hot Tea, hot Broth, or any thing else that is actually hot; for I believe that actual and potential Heats are much of the same Operation.

It has been generally thought to be an Anti-hypnotick, or hinderer of Sleep, which I dare not gainsay, Dr. *Willis* and other learned Men having declared it so; but now it is come into frequent use, the contrary is often observ'd, although perhaps Custom, as it does with Opium, alters its natural Qualities.

I am told, that our three Kingdoms spend about 100 Tun a Year, whereof *England* spends about 70 Tun; which at 14 Pounds a Tun. (a middle Price now a-days) will amount to 20586*l.* sterling: and if it were to be all sold in Coffee-houses, it would reach treble, or 61740 Pounds, which at 10 Pounds a Head, will find Employments for 9174 Persons, although I believe all the People of *England*, one with another, do not spend 5 Pounds each.

Coffee, when roasted, loses about a 4th part, then there is spent about 52 Tun and a half of roasted Coffee, which makes 117600 Pound, or 15252800 Drams, which, if there be 8 Millions of People, is not 2 Drams, or half a Pint of Coffee a piece for a Year.

Besides what we use, we send a great deal abroad, and I doubt not, but in short time, the Gain of what we send abroad, will pay the first Cost of all we shall spend at home; which is one of the best ways to make advantage of foreign Trade.

The Cacao-Tree, n. 93. p. 6007.

XLVII. The Body of a Cacao-Tree is commonly about 4 Inches in Diameter, 5 Foot in height, and above 12 from the Ground to the top of the Tree. These Trees are exceedingly different amongst themselves; for some shoot up in 2 or 3 Bodies, others in one. Their Leaves are many of them dead, and most discolour'd, unless on very young Trees. We reckon a bearing Tree yields from 2 to 8 Pound of Nuts a Year; and each Cod contains from 20 to 30 Nuts.

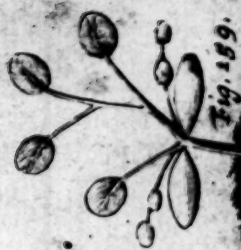
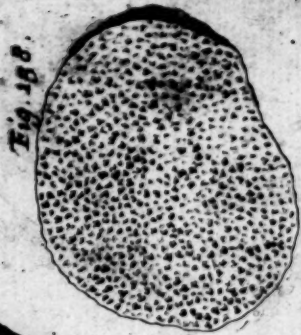
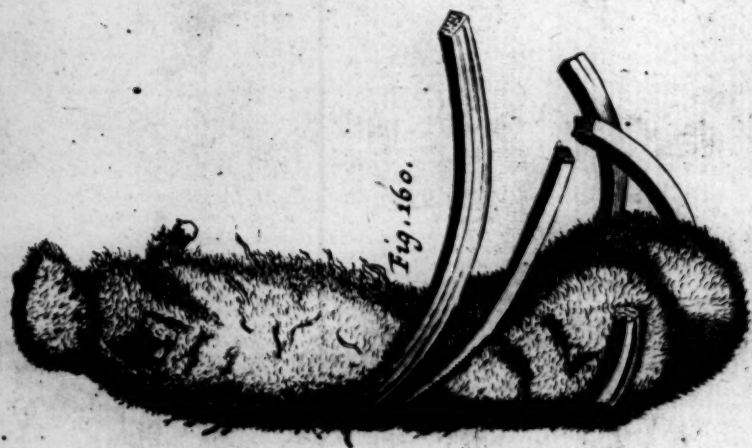
The manner of curing them is, to cut them down when they are ripe, and to lay them to sweat 3 or 4 Days in the Cods, which is done by laying them on Heaps. After this, they cut the Cods and take out the Nuts, and put them into a Trough covered with Plantain-Leaves, where they sweat again about 16 or 20 Days. The Nuts that are in each Cod are knit together by certain Fibres, and have about them a white kind of Pulp, that's agreeable to the Palate. By the turning and sweating, their little Strings are broken, and the Pulp is imbibed and mingled with the Substance of the Nut. After this, they are put to dry 3 or 4 Weeks in the Sun, and then they become of a reddish dark Colour.

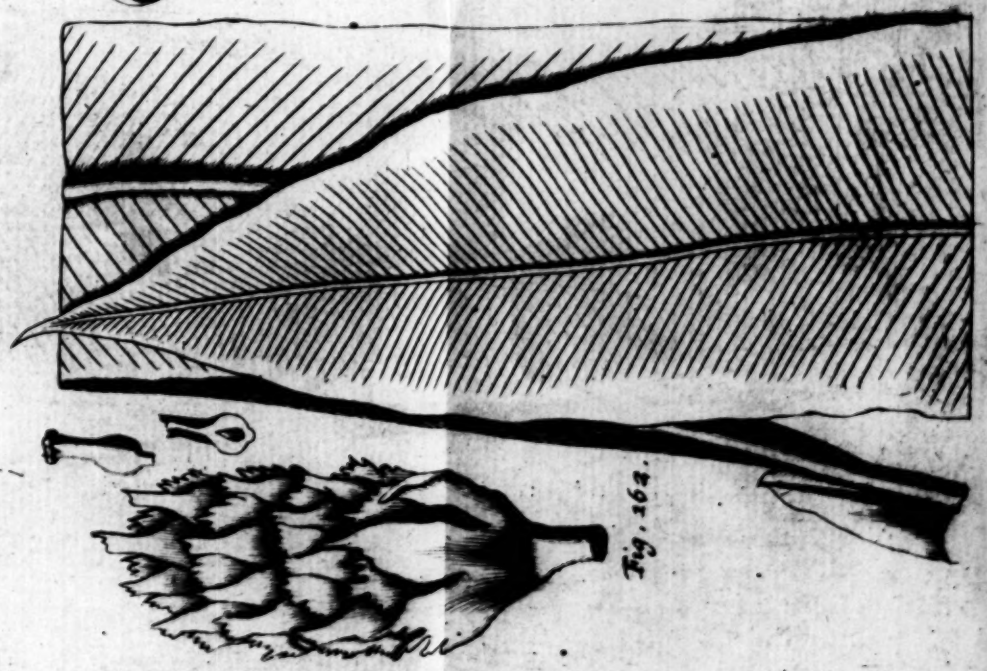
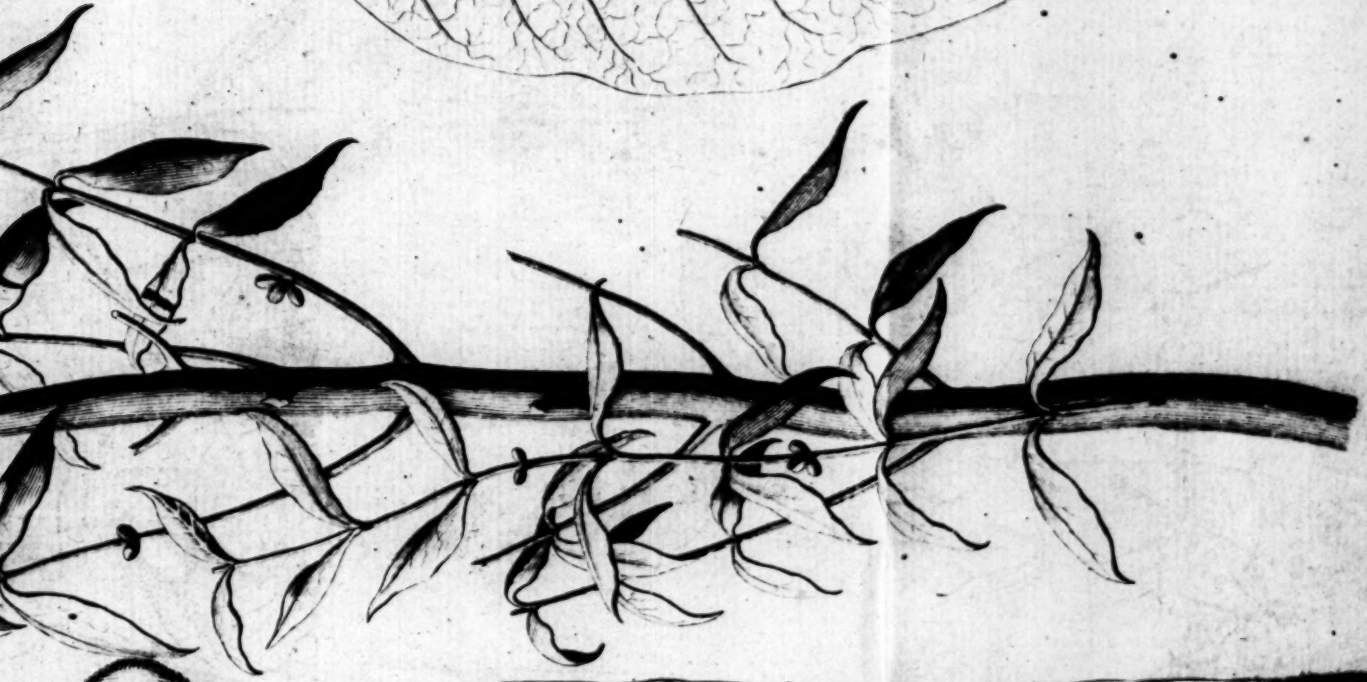
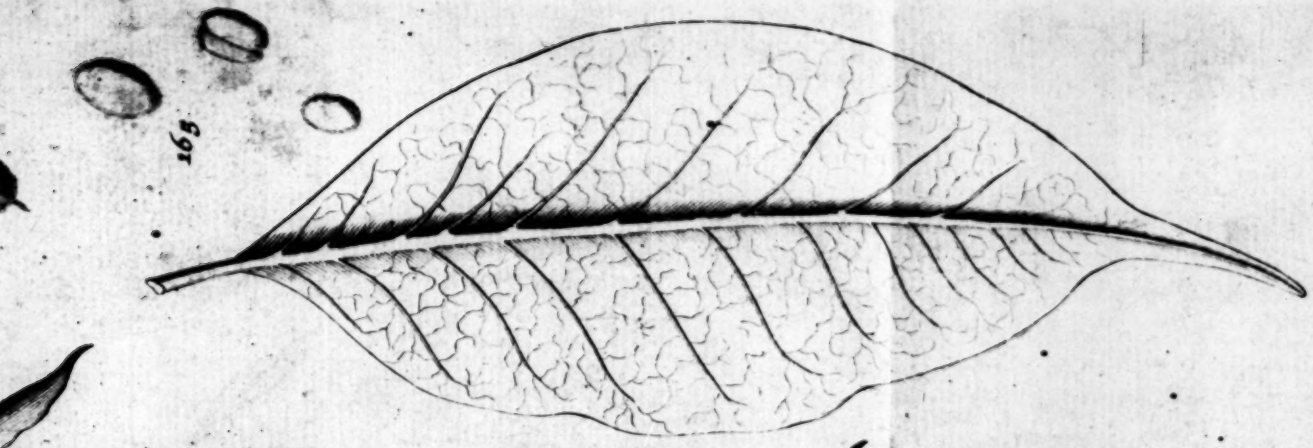
The Cods grow only out of the Body, or great Limbs and Boughs, and at the same Place there are Blossoms, and young and ripe Fruit.

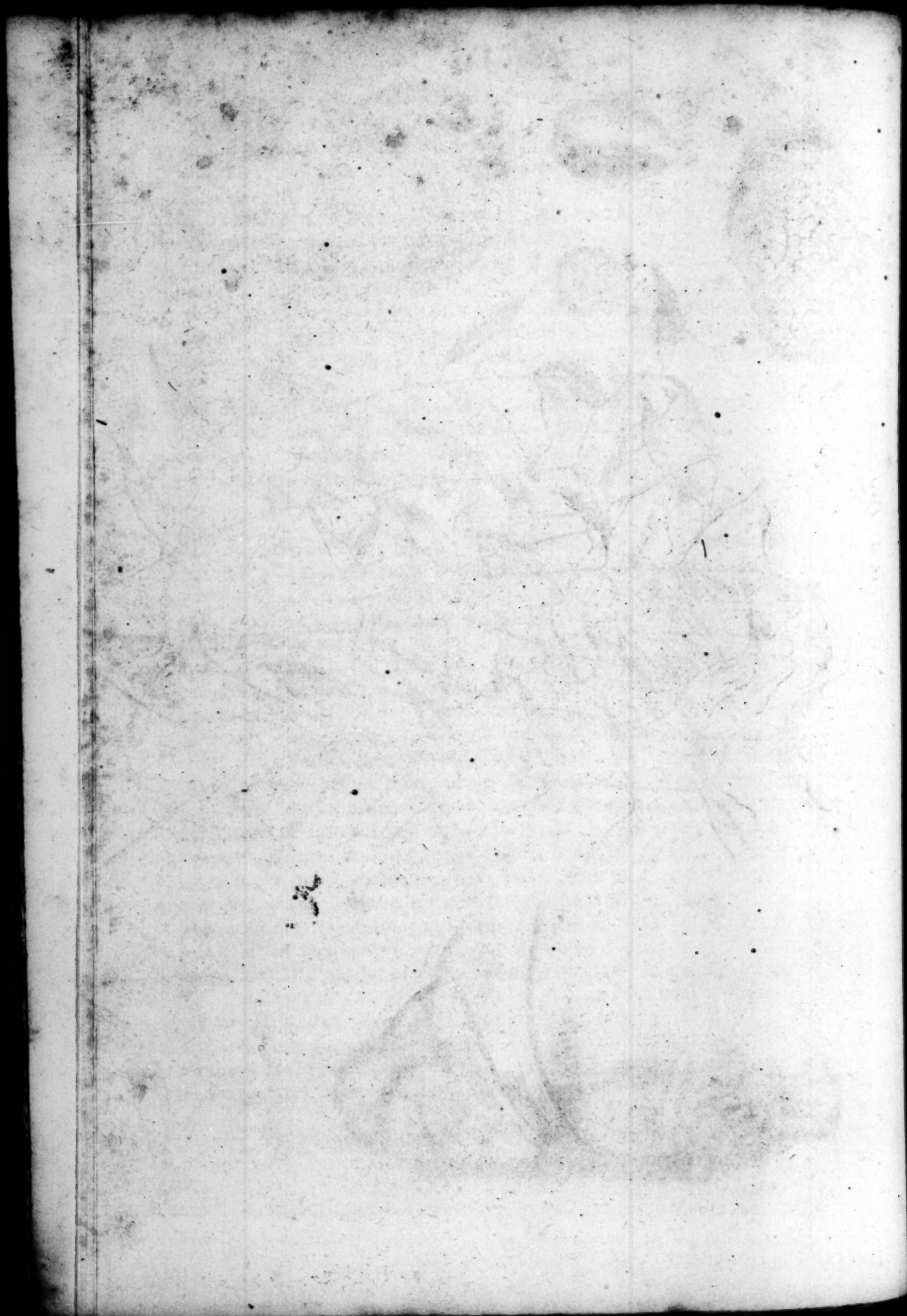
The greatest Crop at most of our Cacao Walks in *Jamaica*, is in *December* or *January*: But at one of *Col. Muddiford's* Walks, they bear most in *May*; yet it's not above 5 Miles from those Walks, which bear always in *December*: But those that bear then, have some Fruit in *May*, as the other have in *December*.

It's planted first in the Nut, always under shade. Some do it under *Cassava*; others, under *Plantain-Trees*, and some in the Woods. The *Spaniards* use a certain large shady Plant, call'd by them *Madre di Cacao*, we only the others. It must also be always sheltered from the *North-East* Winds. We seldom transplant, only where it fails, as it doth many times in open, poor, and dry Lands; for this Tree requires to have a flat, moist, low Soil, which









which makes them to be planted commonly by Rivers, and between Mountains; so that it is ill living where there are good Cacao-Walks. In a Year's time the Plant comes to be 4 Foot high, and hath a Leaf 6 times as big as an old Tree, which, as the Plant grows bigger, falls off, and lesser comes in their Place.

The Trees are commonly planted at 12 Foot distance, and at 3 Years old, where the Ground is good, and the Plant prosperous, it begins to bear a little; and then they cut down all, or some of the Shade; and so the Fruit increases till the 10th or 12th Year; then the Tree is supposed to be in its Prime. How long it may continue so, none with us can guess; but it's certain, the Root generally shoots out Suckers, that supply the Place of the old Stock when dead or cut down, unless when any ill Quality of the Ground or Air kills both.

Cacao was originally of these *Indies*, and wild; towards *Maracajo* are divers Spots of it in the Mountains; and I am informed the *Portuguese* have lately discovered whole Woods of it up the River *Maranon*.

The Cacao passes by Detail for Money in *New-Spain*, and the Silver Countries.

XLVIII. The *Myrtus Arborea, Foliis Laurinis aromatica, Piementa*, or *Jamaica Pepper-Trees*, has a Trunk as thick as ones Thigh, rising straight about 30 Feet high, covered with an extremely polite or smooth Skin, of a gray Colour, and branched out on every Hand, having the Ends of its Twigs set with Leaves of several Sizes; the largest being 4 or 5 Inches long, and 2 or 3 broad in the Middle where broadest, and when it decreases to both Extremes, ending in a Point, smooth, thin, shining, without any Incisures, of a deep green Colour, and standing on such long Foot-Stalks, when bruised very odoriferous, and in all things like the Leaves of a Bay-tree. The ends of the Twigs are branched into Bunches of Flowers, each Foot-stalk sustaining a Flower, made up of 4 herbaceous or pale green *Petala*, bowed back, or reflected downwards, within which are many *Stamina* of the same Colour. To these follow a Bunch of crowned or umbilicated Berries (the Crown being made up of 4 *Foliola* or small Leaves) which are bigger when ripe than Juniper-Berries, at first when small, greenish; but when ripe, they are black, smooth and shining; containing in a moist, green, aromatic and biting Pulp, 2 large *Acini*, or Seeds, separated by a Membrane lying between them; each whereof is an Hemisphere, and both joined make a Globe or Spherical (appearingly one) *Acinus*, whence *Clusius* makes it one Seed divisible into 2 Parts.

The Jamaica
Pepper-tree,
by Dr. H.
Sloan, n.
192. p. 462.

Fig. 166.

It grows on all the hilly Parts of the Island of *Jamaica*, but chiefly in the North-side thereof: and whenever these Trees grow, they are generally left standing when other Trees are fell'd, and they are sometimes planted where they never grew, because of the great Profit from the cured Fruit, sent in great Quantities yearly into *Europe*.

It flowers in *June*, *July* and *August*, but in several Places sooner or later, according to their Situation and different Season for Rains; and after it flow-

ers,

ers, the Fruit soon ripens; but 'tis to be observ'd, that in clear'd open Grounds, 'tis sooner ripe than in thick Woods.

There is no great difficulty in the curing, or preserving of this Fruit for use; 'tis for the most part done by the Negroes, they climb the Trees, and pull off the Twigs with the unripe green Fruit, and afterwards carefully separate the Fruit from the Twigs, Leaves, and ripe Berries. Which done, they expose them to the Sun, from its rising to setting, for many Days, spreading them thin on Cloths, turning them now and then, and carefully avoiding the Dews, which are there very great. By this means they become a little wrinkled, or rugous dry, and from a green change to a brown Colour, and then they are fit for the Market, being of different Sizes, but generally of the bigness of black Pepper, something like in Smell and Taste to Cloves, Juniper-Berries, Cinnamon, and Pepper, or rather having a peculiar mix'd Smell, somewhat a-kin to them all: whence the Name of All-spice. The ripe Berries are very carefully separated from those to be cured, because their wet and plenteous Pulp renders them unfit for Cure. Whence these Berries always coming unripe dried into *Europe*, has been the Occasion of Naturalists thinking it to be *Fruetn umbilicato sicco*. The more fragrant and smaller they are, they are counted the better.

This Fruit with Water distill'd *pec Vescam*, yields a very odoriferous Chymical Oil, sinking to the bottom of Water like Oil of Cloves. It may deservedly be counted the best and most temperate, mild, and innocent of common Spices; and fit to come into greater use, and to gain more ground, than yet it hath, of the *East-India* Commodities of this kind; almost all of which it far surpasses, by promoting the Digestion of Meat, attenuating rough Humours, moderately heating, strengthening the Stomach, expelling Wind, doing those friendly Offices to the Bowels, as we generally expect from Spices.

It is now commonly sold by Druggists for *Carpobalsamum*, which I suppose came from *Hernandez*, who says it may be its *Succedaneum*; but it is not that Fruit, but seems more fragrant and less astringent and balsamick. *Clusius* says, that it takes away, if chewed, a stinking Breath: *John de Barrius* tells us, 'tis one of the Ingredients of Chocolate in *New Spain*: and *Franciscus Vria*, who brought it from *New Spain* and gave it to *Redi*, said, it was there commended against the Epilepsy and *Gutta serena*, which he in divers Persons tried but without success; but he at the same time says, he thinks it a good Stomachick and Cephalick Medicine, moderately given.

Exper. Nat.
p. 132.

It has been taken by *Clusius* for *Pliny's Cariophyllon*, and by others for *Amomum*; but it is not likely that it was known to the Antients, not being known to grow in the *East*, but *West-Indies*.

It is very likely that *Hernandez* does describe this under the Name of *Kocoxite seu Piper Tavaſci*; his Description agreeing in every thing but the Flower; which no ways agrees to this. And perhaps this is the Tree which *Piso* describes under the Name of *Anhuiba Miri*.

Cinnamon
and Milli-
um, n. 172.
p. 1031.

XLIX. *M. de Vilermont* has a sort of Cinnamon, which comes from *Guadaloupe*

daloupe, which is white; and another sort, which comes from *Maragnan*, which is like that of *Ceilon*.

He has an Ear of the small *Milium* of *Guinea*, about 10 Inches long, made just like the great Knob of a Cane: the Grains are no bigger than a Pin's Head, and are very good to eat; the Negroes making their finer Cakes of them.

L. Arbor baccifera, laurifolia, aromatica Fructu viridi calyculato ramoso, or *The wild Cinnamon-Tree*, commonly but falsely call'd *Cortex Winteranus*, has a Trunk about the thickness of one's Thigh, rising to about 20 or 30 Foot high, having many Branches and Twigs hanging downwards, making a very comely Top. The Bark consists of 2 parts, one outward, and another inward. The outward Bark is thin as a mill'd Shilling, of a whitish ash or grey Colour, with some whiter Spot here and there upon it, and several shallow Furrows of a darker Colour, running variously thro it, making it rough, of an aromack Taste. The inward Bark is much thicker than Cinnamon, being as thick as a mill'd Crown Piece; smooth, of a whiter Colour than the outward, of a much more biting and aromack Taste, something like that of Cloves, and not glutinous like Cinnamon, but dry and crumbling between the Teeth. The Leaves come out near the ends of the Twigs, without any order, standing on Inch-long Foot-stalks; they are each of them 2 Inches long, and one Inch broad, near the end where broadish and roundish, being narrow at the beginning, from whence it augments in breadth to near its end, of a yellowish green Colour, shining and smooth, without any Incisures about its Edges, and somewhat resembling the Leaves of Bay, or *Laurocerasus*. The ends of the Twigs are branched into bunches of Flowers, standing something like Umbels, each of which has a Foot Stalk, on the top of which is a Calix, made up of some *Foliola*, in which stand 5 scarlet or purple *Petala*, within which is a large *Stylus*. To these follow so many Calyculated Berries, of the bigness of a large Pea, roundish, green, and containing within a mucilaginous pale-green thin Pulp, 4 black shining Seeds, or *Acini*, of an irregular Figure.

All the parts of this Tree when fresh are very hot, aromack and biting to the Taste, something like Cloves, which is so troublesome, as sometimes to need a Remedy from fair Water.

It grows in the Low-Land, or *Savanna* Woods, very frequently on each side of the Road between *Passage Fort* and the Town of *St. Jago de la Vega* in *Jamaica*, in *Antegoa*, and other the *Caribbee* Islands.

The Bark of this Tree is what is chiefly in use, both in the Plantations of the *English* between the Tropicks in the *West-Indies*, and in *Europe*; and is without any Difficulty cured, by only cutting off the Bark, and letting it dry in the Shade.

It is in use in the *West-Indies*, by the more ordinary sort of People, in place of all other Spices, being thought very good to consume the immoderate Humidities of the Stomach, help Digestion, expel Wind, &c.

It is likewise, as well there as in *Europe*, thought a very good Remedy against the Scurvy, and to cleanse and enervate the Blood, being in *London* at Druggists and Apothecaries Shops used for those purposes, under the name of *Cortex Winteranus*, which it is not, but may very well supply its Place. It is in the *West-Indies* mixed and given with Steel, and other Medicines; but if the Patient be any way of a hot Constitution, it does more Harm than Good, being very warm.

Rum, a Vinous Spirit drawn from *Molassus*, or bad Sugar fermented with Water, if it be mixed with some of this Bark, it loses in part its loathsome empyreumatick Smell.

This Bark, if mixed with Water, and distill'd *per Veficam*, yields an aromatick Oil, sinking to the bottom of Water like Oil of Cloves, with some small Quantity of which it being mixed, has sometimes been sold for true Oil of Cloves. *Peter Martyr* mentions it under the Name of *Cortex, Cinnamomi Saporem, Gingiberis Amaritudinem, & Caryophilli suavem Odorem præ se ferens*. *Nic. Monardes* describes it under the Name of *Lignum Aromaticum*; *Clusius* calls it *Lignum, seu potius Cortex Aromaticus*; and I question not but this is the same with the white Cinnamon, or the *Canella Alba*, in some other Authors. *Linschoten* in his Description of *America*, translated into *French*, gives an account of it under the Name of *Arbre, ou les Pigeons nichent*; *Dr. Trapham* calls it *Winter-Bark, or West-Indian Cinnamon-tree*; *Hernandez*, and *Ximenes, Caminga*.

But it may be doubted whether this be the *Ascopo* of *Havot*.

The true
Cortex Win-
teranus, by
Dr. H. Sloan,
n. 204. p. 922.

LI. Capt. *Winter*, who went out with Sir *Fr. Drake*, when he went round the World, at his Return brought with him from the Streights of *Magellan* an aromatick Bark, which had been very helpful to those of his Ship, both used instead of other Spices with their Meat, and as a Medicine very powerful against the Scurvy. *Clusius*, from this Captain's Name, calls it *Cortex Winteranus*, and the Tree *Magellanica Aromatica Arbor*. The Writer of the Journal of the Dutch Ships that went to the Streights of *Magellan* about 1599, calls it *Lauro similis Arbor, licet procerior, cortice Piperis modo acri & mordenti*. And *Sebald de Weert*, who was there, says, that both Leaves and Bark were used with their Meat and Muskles, to correct them in so cold a Climate. *Caspar Bauhine* calls it *Laurifolia Magellanica Cortice acri*; *Johnston, Arbor Laurifolia Magellanica*.

Fig. 168. But Mr. *Geo. Handyside*, who came from thence about 2 or 3 Years since, gives the best account of it; having brought with him a Specimen, or Sample of its Leaves and Flowers on the Twig and its Seed; by which I cannot reduce it to any of our kind of Plants so well as the *Periclymenum*: and therefore I shall call it, tho it differs in many things from the *Honyfuckle, Periclymenum rectum Foliis laurinis, Cortice acri aromatico*.

He assured me that this Tree rose to be higher and larger than an Apple-Tree, spreading very much both in Root and Branches: The Twigs had on them Leaves of a light green Colour on their upper side, standing on half-

half-inch long Foot-stalks; are an Inch and half long, and an Inch broad in the middle, where broadest, and whence they decrease to both ends, ending blunt. The Flowers come, *ex alis Foliorum*, standing on $\frac{1}{2}$ inch long stalks; 2, 3, or more of them together, something like those of the *Perichymenum*, each of them are milk-white *Pentapetalous*, and smell like Jessamine; to which succeeds an oval Berry, made up of 2 or 3 or more *Acini*, or little Berries, standing together on the same common Foot-stalk, of a light green Colour, with some black Spots: and in these Berries are contained several black aromack Seeds, something like the Stones in Grapes.

It grows in the middle of the *Streights of Magellan* very plentifully.

The Leaves of this Tree were used with other Herbs, by Mr. *Handyside* for Fomentations in several Cases, with very good Success; but he admired most the use of the Bark inwardly, boiling half a Drachm of it with some Carminative Seeds, and giving it so to those of the Ship who were under his Care, very much afflicted with the Scurvy. It usually sweated them, and they were very much relieved. The same Medicine likewise he administered to a great many of the Ship, who were very ill by eating a poysonous sort of *Seol* in those parts, call'd a *Sea-Lyon*; with which they had a very great Amendment, altho they had been so ill with feeding on this Creature, as to lose most of their Skins, which peel'd off their Bodies by degrees, and in large Pieces; so that the Antidote to this strange Poyson was to be had very near it, and was very much extoll'd by this Gentleman, who was put to a stand to know what to do in this strange Case, altho he very well understood the *Materia medica*.

By the Description of this Tree and that of wild Cinnamon, it appears, that the *Cortex Winteranus* commonly sold in Shops, is not the true *Cortex Winteranus*. But I must needs say, tho they are the Barks of two very differing Trees, and growing in very differing Places, and appear quite another thing in their outward Faces: Yet their Taste is much the same, and I believe they may be used as a *Succedaneum*, one for another; tho the true be much to be valued beyond the false, being much more aromack.

LII. I have discoursed a poor meer *Irish* Labourer, (who, by having worked many Years under a head Gardiner, in a Gentleman's Garden, has got a Genius of Planting) who has follow'd the Propagation of Elms, by the Seed; (a way if known, totally neglected among all Planters) which Seed he finds in the former part of the Year: and he has raised in small Beds such vast numbers of them, that he sells them of 3 or 4 foot long, at 2 s. a hundred, and will carry them any where within 5 Miles, and plant them into the Bargain.

An Account of the Propagation of Elms-Seed, by Sir Rich. Bulkley, n. 205. P. 271.

A sort of
Sugar from
Maple.
n. 171. p. 988.

LIII. The Savages of *Canada*, in the time that the Sap rises in the Maple, make an Incision in the Tree, by which it runs out, and after they have evaporated 8 Pounds of the Liquor, there remains 1 Pound, as sweet, and as much Sugar, as that which is got out of the Canes; part of the same Sugar is sent to be refined at *Roven*.

The Savages have practised this Art, longer than any now living among them can remember.

There is made with this Sugar a very good Syrup of Maiden-hair, and other capillary Plants, which is used in *France*.

Oak prepared
for Tanning,
by Mr.
Ch. Howard
of Norfolk,
n. 105. p. 93.

LIV. Every part of the Oak-Tree, of what Age or Growth soever, and all Oaken Coppice Wood of any Age or Size, being cut and procured in Bark-ing-time, will tan all sorts of Leather, as well at least as Bark alone.

This Material being gotten in its proper Season, it must be very well dried in the Sun, and more than Bark, then housed dry, and kept dry for use; and when it is to be used, the greater Wood may be shaved small, or cleft, and the small bruised with a Hammer and cut small; which done, it must again be dried very well upon a Kiln, and then ground as Tanners usually do their Bark.

Such Wood, as it is to be used presently after 'tis gotten, will require the better and more drying upon the Kiln; otherwise, it will blacken and spoil all the Leather.

Instead of an Anvil, to beat and bruise the tanning Stuff upon, fit into a wooden Block a Plate of Iron about 4 Inches deep, 9 Inches broad, and 12 Inches long. The Hammer for bruising the Stuff may be of 6 *l*. weight, and have the Head about 3 Inches square, to work with both Hands; but to work with one Hand, or for a Youth to use, let it be of about 3 *l*. weight, and the Head about 2 Inches square. The surface of one end of these Hammers is best to be smooth, but that of the other dented, the better to enter into the Stuff for quicker Dispatch. They are to be well steel'd at both ends, the handles of these Hammers may be about a Foot long; the bigger ought to be somewhat longer.

The Knife to cut the bruised Stuff, may be 8 or 9 Inches broad, and near as much in Depth, made like a Tobacco-Knife, with a handle to work.

Where Oak is scarce, Thorns may indifferently well supply that Scarcity. Birch ordered and used instead of Oak, is very fit for Soal-Leather.

As these Ingredients will tan better than Bark alone, and that with far less Charge, so may this Invention save the felling of Timber, when the Sap is up; which when 'tis done, causes the outside of the Trees to rot and grow worm-eaten; whereas, if the Trees had been fell'd in Winter, when the Sap was down, they would have been almost all Heart, (as they call it) and not so subject to Worms. Besides that, this Invention will greatly improve the value of Underwoods.

LV. There is no such Dwarf-Oak in *England*, growing wild, as was sent you out of *New-England*; nor in any other Country where we have been; unless it be the *Ilex Coccifera*, which is a low Shrub, bearing large Acorns, and hath a prickly Leaf like Holly. If it prove that, it will be a luciferous Discovery.

A Dwarf Oak from New-England; By Mr. F. Willoughby, n. 58. p. 1700.

LVI. Five Leagues from *Marseilles* are very high Mountains, which are (for the most part) covered with Forests of Pine-Trees, which there grow wild; half a League out of the Road, you see the making of Pitch, Tar, Rosin and Turpentine, which is thus, viz. in the Spring-time when the Sap runs most, they pare off the Bark of the Pine to make the Sap run down into an Hole, which they cut at the bottom to receive it; as it runs, it leaves a Cream or Crust behind it, which they take and temper in Water, and sell, by a Cheat, for white Bees-Wax, that they make Flambeaus of, and is a great deal dearer. Then they take up the Juice in Spoons from the bottom, and after they have so gotten a good Quantity, they strain it thro a Grocer's Basket, such as they put their *Malaga Raisins* in; that which runs thro easily is the common Turpentine. Then they take that which remains above, and adding a sufficient Quantity of Water, distil it in an Alembick; that which is so distilled is Oil of Turpentine, and the *Calx* that remains is common Resin. Then they cut the Stock of the Tree into large Chips, and pile them hollow in a Cave; covering it on the top with Tiles, but so as to let some Air come in to feed the Fire; then burning them, there runs a thick Juice down to the bottom, where they make a small Hole for it to run out at, (a larger Hole would set it all in a Flame) and that which so runs out is Tar. Then they take off that, and boiling it gently over again, to consume more of the Moisture, they set it to cool; which when cool is Pitch.

The Way of making Pitch, Tar, Rosin and Turpentine. By Mr. Tho. Bent, n. 243. p. 291.

LVII. In *Jamaica*, the neighbouring Isles, and Continent of *America*, grow many sorts of Mistletoe; parasitical Plants, as they are called by some, or *Epidendra* by others; which grow on the Bodies or Arms of Trees, after the manner of Mistletoe, like to which they bring forth Roots, Leaves, Stalks, Flowers and Seed. From this likeness I have given the Name *Viscum* to all the several Families of them; tho they differ very much from it, and almost as much amongst themselves.

A sort of Mistletoe in Jamaica; By Dr. Hans Sloon. n. 251. p. 113.

There is one Family among them which I call *Viscum Cariophylloides*, from having its Seed-Vessel somewhat like that of *Clove-July Flowers*, and a particular one of that Family which I name *Viscum Cariophylloides maximum*, *Flore tripetalo pallide luteo*, *semine filamentofo*, and which is commonly in that Island called Wild-Pine; whose Description follows. A great many brown Fibrils encompass the Arms, or take firm hold of the Bark of the Trunk of the Trees whereon they grow. Not as Mistletoe, entering the Bark or Wood, to suck Nourishment, but only weaving and matting themselves among one another, and thereby making to the Plant a firm and strong Foundation. From hence rise several Leaves on every side, as *aaaa*, after the manner of Leeks, *Ananas*, whence the Name of Wild-Pine,

Catal. Jam. Plan.

Fig. 170.

Pine, or Aloes, being folded or inclosed one within another; each of which is two Foot and a half long; from a 3 Inch breadth at Beginning, or Base, ending in a Point; having very hollow or concave inward-sides, is made within a very large Reservatory, Cistern, or Basin, *b.* fit to contain a pretty deal of Water; which in the rainy Seasons falls upon the uppermost Parts of the spreading Leaves, which have Channels in them, conveying it down to the Cistern, where it is kept, as in a Bottle; the Leaves, after they are swelled out like a Bulbous Root to make the Bottle, bending inwards, or coming again close to the Stalk, by that means hindering the Evaporation of the Water by the heat of the Sun. They are of a light green Colour below, and like Leeks above. From the midst of these rises a round, smooth, strait, fresh Green coloured Stalk, 3 or 4 Foot long, *c.* having many Branches; when wounded, yielding a clear mucilaginous Gum. The Flowers come out here and there on the Branches; they are made up of 3 long yellowish, white, or herbaceous *Petala*, and some Purple-ended *Stamina*, standing in a long *Calix*, or *Tubulus*, made up of 3 green viscid Leaves, with purple Edges, to which follows a long triangular *Capsula*, *d.* greenish Brown, being somewhat like those of the *Cariophylli*; having under it three short capsular Leaves, and within several long pappous Seeds, the Seed it self being oblong, pyramidal, and very small, having very soft Hairs, Down or *Tomentum*; much longer in proportion to the Seed, than any *Tomentum* I know; being as long as the Pod or *Capsula*.

It grows on the Arms of Trees, every where in the Woods, as also on the Barks of their Trunks; especially when they begin to decay, their Barks receiving the Seed, and yielding then more easily to the Fibrils of this Plant's Roots, which in some time dissolves them, and ruins the whole Trunk.

The Contrivance of Nature in this Vegetable is very admirable; the Seed has long and many Threads of *Tomentum*, not only that it may be carried every where by the Wind, as the Pappous and Tomentose Seeds of *Hieracium*, *Lysimachia*, &c. are, but also, that it may by those Threads, when driven thro the Boughs, be held fast, and so stick to the Arms and extant Parts of the Barks of Trees. So soon as it sprouts or germinates, although it be on the under parts of a Bough, or Trunk of the Tree, its Leaves and Stalk rise perpendicular, or strait up: Because if it had any other Position, the Cistern before mentioned (by which it is chiefly nourished, not having any Communication with the Tree) made of the hollow Leaves, could not hold Water, which is necessary for the Nourishment and Life of the Plant.

In the mountainous as well as dry low Woods, in scarcity of Water, this Reservatory is necessary, and sufficient, not only for the Plant it self, but likewise is very useful to Men, Birds, and all sorts of Insects; whither in scarcity of Water they come in Troops, and seldom go away without Refreshment.

There are some Contrivances in Plants growing in Europe, which come near those of this kind of Vegetables, in some Particulars. The *Virga Pastoris*,

it, or wild Teasel (and most Plants call'd Perfoliated) has its Leaves inclosing its Stalk, and so set by pairs opposite to one another, and joined by their Bases, that they may make a hollow Place, fit to contain some Water, which tho open, yet without doubt contributes to the perfecting of the Plant.

Several *Fuci* are lately discovered to have Seeds, which, when ripe, break out of their Places, and by means of a glewy Juice fasten themselves to the Stones, or other Substances at the bottom of the Sea, where they are to grow. The common *Viscum* had such a glewy Substance, I suppose, for fastning its Seed to the Barks of Trees.

Small Mosses, heretofore thought to have no Seed, are now known to have great Plenty; and that so small, as I have seen it rise up from the ripe Head, in form of Smoak; which is without question that it may be carried by the Air and Wind, to Walls, Trees, or other fit *Matrix* for its Vegetation.

There is a *Fungus*, call'd by *Clusius*, *Fungus minimus anonymus*; and by *Dr. Merret*, *Campaniformis, niger multa semina plana in se continens* (which I have shewn the *R. Society* many Years since) that when ripe opens in the Rain, by which one filling a Cup, wherein lies its Seeds, they are washed out on every hand, to propagate its kind.

There are many Families of Plants with Pappous, or Tomentose Seeds; as *Dandelion's*, *Erigerum's*, *Lyfimachia's*, *Clematis's*, *Anemone's*, &c. which being ripe, their Seeds are by means of their Feathers, or Wings, scattered to all neighbouring Parts by the Wind. This is so effectual a way, that the *Hort. Bleff. P. 10.*
Aster Canadensis annuus non descriptus, *Brunyer*, or *Conyza, annua alba acris*, *Morif.* (which came at first from *Canada*) is now become a wild Plant in many Places of *Europe*, where it never was observed to grow, and far from the Gardens where it was first planted; from whence the Seed had been carried by its Wings; so that I have seen it in some Parts of *France*, very many Leagues from such Places.

There are likewise many Plants, which have Seed-Vessels so contrived as with a Spring, and sometimes smart Noise, when they are ripe, to throw off their Seeds several ways, to a considerable distance. Most Plants having Pods, as *Furze*, &c. those called *Noli me Tangere*, or *Herbæ Impatientes*, *Cucumis asininus*, *Cranes-bills*, and many others, have this Artifice to sow themselves. Amongst those who have this Property, none is more surprizing than one in *Jamaica*, called Spirit-Weed, which when its Seed is ripe, the Vessel containing it, on the least touch of whatever is wet, does instantly open it self, and with a smart Noise, throw its Seed several ways to a considerable distance; likely the design of Nature being, that the rainy Season being proper for sowing, its Seed should be kept in its Seed-Vessel, the best Preserver of it from Injuries till then.

Lychnis's, *Poppies*, *Antirrhinum's*, and many others, have their Seeds in Heads, which, when ripe, are open at top; and by the Winds, and help of their Partitions, are scattered and directed to all Quarters.

These

These Instances, and many more, very obvious and wonderful, tho not taken notice of, might be given to shew the great Endeavours of Nature to perfect the *Individuum*, and propagate the kind; which for that reason, I am apt to believe, are all (without the loss of one Species) preserved to us, from the Creation to this Day.

The Silver-Pine from the Cape of Good Hope; By Dr. H. Sloan. n. 198. p. 664.

Fig. 171.

Fig. 172.

LVIII. A Branch of the Silver-Pine, or *Conifera Salicis facie, Folio & Fructu, Tomento sericeo candicante, obductis semine pennato*, was lately brought into England from the Cape of Good Hope, by Mr. Goddard. The Twig of this Tree had a great many Leaves set round it very close to one another, so as to hide the Twig it self there where they grow; each of the largest of them being about 4 Inches long, and $\frac{3}{4}$ of an Inch broad, in the middle where broadest, from whence they decrease towards both Extremes, ending in a Point; being like those of the Osier Willow, only broader, and all covered over with the thickest, finest and longest white Silken Hair or Down, that ever any Plant I remember to have seen has. The Cones are of the bigness of those of the Cedars of *Lebanon*, and of the same shape; the *Cuticula*, or small Skin of each Scale, being covered over with a white short Down or Wool, shining also like Silk; between the Scales is lodged the Seed C. which is almost as large as the Pine-Nut, near the same shape, of a dark brown Colour, and having a rising eminent Line or Belly running thro a Membrane D. which has on its top 4 Feathers, like those belonging to the Seeds of *Clematis*; which being between the Scales, and rising above them, adds a very great Beauty to the Cone; and may likewise serve for Wings, by means of the Wind, to loosen or carry the Seeds to distant Places, thereby propagating it self.

Dr. Plucknet has figur'd it under the Name of *Leucadendros Africana, Arbor tota argentea, sericea Foliis integris*; Atlas-Tree, D. Herman.

Another Coniferous Tree, from the Cape of Good Hope; By Dr. H. Sloan. n. 198. p. 666.

Fig. 173.

LIX. *Conifera, Alypi folio, Seminibus pennatis pluribus in medio Coni conglomeratis, & non inter Squammas, aliorum Conorum more, nascentibus.*

A Branch of this Tree with its Fruit was lately brought from the Cape of Good Hope, by Mr. Goddard. It had a brown-colour'd smooth Bark with a whitish hard Wool, and small Pith. The Leaves (expressed to their natural Bigness F.) were round it without any Order, very thick set, having no Foot-Stalks, being about 2 Inches and $\frac{1}{2}$ long, and about $\frac{1}{2}$ of an Inch broad, near the farther end where broadest, smooth, hard, and of a brownish or dirty green Colour. On the top of the Branch comes the Fruit, G. which is surrounded by 3 or 4 Twigs, H. I. K, overtopping it, and with their Leaves almost hiding it. It is about 5 Inches long, and is made up of many Scales, hard and red, enclosing one another. The lowermost and outwardmost being very short, the inwardmost 4 Inches long, each of them ending in a Point; some Scales having on their outsides a gummy Juice. In the middle of these Scales were the first Rudiments of many Seeds, as L. the same not being fully ripe; each of which is set about with a great Quantity of $\frac{1}{2}$ Inch long, yellow, fine, silken Down, M. having 2 Inches long *Sylas*, or

or String N. and yellowish Membranes O. enclosing the *Stylus* and *Tomen-
tum*, being feather'd at top with Feathers, like the Silver Pine, and for the
same Purposes.

LX. 1. There are several sorts of Vegetables that will grow the wrong end
set downwards in the Ground, as Elders, Bryars, Sallies, Willows, the black
Elder, Vines, and most Shrubs; two or three of their Joints being cover'd in
the Mould, and the Stem cut off near the overmost Joint, which should be
half cover'd in the Mould, and the Mould somewhat raised, as it spurts out
and grows. Dr. B. Currant-trees, and such like as are of a soft Wood, and
quick Growers, seem most apt to this Improvement. Dr. T.

2. The Branch of a Plant being laid in the Ground, whilst yet growing on
a Tree, and there taking Root, being cut off whilst so growing, will grow
on both ends, if it be well rooted in the Propagation; and the like care had
of the last Knot or Joint, as was before prescribed. Dr. B. The Layers of
those Trees and Shrubs mentioned in the former Observation, will grow
on both ends, and aptly parted when they have spread Roots both ways,
make two Plants out of each Layer. Dr. T.

3. In the tapping of Trees the Juice certainly ascends from the Root, and
after it is concocted to partake of the nature of the Plant, which feeds as well
on the Air as the Juice furnish'd thro the Root, it descends (as Liquor in an
Alembick) to the Orifice whence it issues. *Ratray*, the learned *Scot*, affirms, that
he hath calculated experimentally, that the Liquor which may be drawn from
the Birch in the Spring-time, is equiponderant to the whole weight of the
Tree, Branches, Roots, and all together. And perhaps this kind of large natural
Alembick, where it may be had, may sometimes prove more effectual than our
little artificial and more troublesome Distillations. And the Congeniality of
the Sun in its alternative Visits, and the assiduous intercourse of the free Air
with the Spirits of the Plant, yet living and growing, may have a more ef-
fectual influence for a specifick Virtue than we are apt to imagine. Tho we
cannot see nor hear the Lungs of Vegetables beating, yet we may sometimes
smell their Breath strong enough both to please and offend exceedingly; as in
Savin, Firs, Cypress, Elder, Rosemary, Myrtles, and generally in all Blossom-
ers. And some that cannot be smelt by us, may yet have a very wholesom
Breath. One Experiment I will here bestow on you: When both my Hands
were manacled for many Years (and sometimes my Arms also) with deep cor-
roding Tetters, to the blush of my many friendly Physicians, and in despite
of many of the best Medicines and Purgations, all was suddenly heal'd, and
has so continued these 20 Years, by the application of the Gum of Plum-
trees dissolv'd in Vinegar. I must not forget to add, that I apply'd Vine-leaves,
and sometimes open'd Raisins to draw a moisture from these Tetters, some
few Days before I us'd the Gum. Dr. B.

Dr. *Tonge* is of opinion, that Sap always rises, and never properly de-
scends, having only a kind of subsiding or Recidivation, which he saith he
cannot call a Circulation, nor resemble to the motion of Liquors in a Pelli-
can, but rather to the sinking of Liquors in an Alembick, whilst the thinner
parts are forced over the Helm; yet somewhat imitating the Motion of

Blood in Animals, forasmuch as it continually supplies the want and expence of Sap in the exterior Parts, from the Stock of the Sap in the Trunk, Root, and Branches.

He understands it thus, that the Sap necessary to the growth of the Leaves, Fruit and upper Branches, being dispensed and converted into the Form necessary for these Purposes, when the Tree is fullest of Sap, in such manner that the Sap in the innermost Coats feeds the innermost, and the Sap of the outward Coats, the outward Parts of Fruits, &c. that which remains in the Body betwixt the several Coats, and betwixt the Bark and Body, begins to condense there also, first into a Gelly, and after into Wood, Bark, Roots, &c. according to the several Places to which it hath subsided. And because it condenseth faster in some parts than in others, according as they be higher or lower, whether it be by Heat or Cold, or Exhalation of thinner parts, the Sap condensed above or below, filling less room, must needs cause the Sap, which is not yet condensed in appearance, to descend or subside, and to sink as it were lower and lower, in the Pores of the Timber and Bark, *i.e.* to be less high, not descend from any place to which it was formerly risen, unless (as in Blood letting) when some lower part is open'd, all the Sap above continually flows thither till the Tree be emptied, or the continual Flux of the Sap (the natural Balsam of the Tree) heal the Wounds, as that of the Blood does those of the Body; and so much quicker and easier, by how much the Air is more favourable, or is better kept out: which he observes for their Direction who are curious in Inoculation, as the ground of their Successes or Miscarriages. The Trees observ'd by the same Dr. T. to run, are the Vine; the Birch, plentifully at Body, Branches and Roots; the Walnut-tree, at the Roots and pruned Branches; some Willows and Sallies, and some sorts of Maples; the Sycamore, which is the greater Maple (some call it a Plane) at a Gash made on the Bark of his Body, and at the Roots and Branches; the Poplar and Asp. Some Woodmen affirm, that in such Oaks as are windshaken, that have large Hollownesses in their Arms and Bodies, they have found great quantities of Sap in the cutting of them, whereof having drank, they quenched their Thirst without any prejudice. To these add the Whitting or Quicking-tree (*Lat. Fraxinus Sylvestris*, and by some, *Fraxinus Cambro-Britannica*) which in its season, as some affirm, will run plentifully, and whence they would have us expect a sovereign Drink against some stubborn Distempers, especially such as are Scorbucal and Splenetick. I have kept (saith Dr. T.) some of the Juice of the Berries (which being expressed ferments of it self) these 2 Years in Bottles, and it has now the taste of an austere Cyder; and I suppose, from its grateful smell, that it may be kept till it ripens, and become a strong vinous Liquor. It is the Household Drink of some Families in these parts about *Wales* and *Herefordshire*; and some out of curiosity have brewed ripe Berries with strong Beer and Ale, and kept it till it transcended all the other Beer in goodness.

Dr. Tonge's Attempts upon the Poplar, Asp, Elm, Oak, Ash, Elder, Whitting-Berry or Quicking-tree, Thorn, Buckthorn, Tile, Nut, Sloe, Briar, Bramble, &c. have not succeeded; and he doubts that they, and all Apples and Pears, have some degree of Gumminess in their Juices, so that they will not run.

4. The Sap apparently riseth by the inward Bark, where you may see the Quick begin, and where the Graft first incorporateth. Dr. B.

Dr. T. observes that there are Circles in Trees which are the Distances of those Films or Coats, by which the Tree receives its yearly increase in thickness. Thro these, looking full of circular Pores, the Sap seems to ascend in the same manner between Coat and Coat, as between the Bark and the Body. Now the Ascent of Sap is by all Parts and Pores of the Tree in such small Quantities, as can hardly be discern'd, unless the Tree be quite sawed off, especially near the Root, for then it will appear how it ascends. In Birches, and such like, the Sap issues very plentifully in all parts of the Body, when they are cut down near the Root.

The Bark is double, outward and inward; the outward is dry, and in some Trees rough; the inner is probably a superadded new Coat of that Year's growth, or something like it, between the nature of Wood and Bark. The Sap rises within and without that superadded Coat.

To perfect the Experiment about Sap, and to find whether it ascends more n. 46. p. 913. or less in the prick'd Circles of the Body, than in those betwixt the Body and the Bark; let the Tree, exempted from all its Sap the Day before, be first pierced with an Augre, only thro the Bark, and the quantity of Sap it yields in an Hour exactly measur'd and weigh'd; then at the same time, let another Hole be bor'd into the Body of the Tree, above an Inch and a half deep, and so round about on every side of the Tree, some deeper and some shallower, with a good large Augre, and one quite thro sloping. From which Experiment, after various Trials, may be found the difference of the Sap, rising on the North and South; and so likewise of that which comes from the Bark only peel'd off, and that which ascends in the inner part of the Tree. The Weight may be also compared of that which issues from the Bark, with that which issues from the Body. The internal Heart-Sap may also be drawn apart, by boring a smaller Augre-hole in the middle of a greater, and fitting it with a long Pipe adjusted to that inner Orifice.

5. Dr. Beal saith, experimentally, that if a Circle be drawn round about any common *English* Tree, as Oak, Elm, Poplar, &c. by Incision, to the Timber (how thin soever the Knife be) so that no part of the Rind or Bark, to the very solid Timber, be uncut, the Tree will die from that part upwards. Only the Ash (of all that I could try) will grow on and prosper, notwithstanding the Incision. My Brother (T. B.) shew'd me some old and huge Ashes, which were bared of the Bark by the Deer, from the Root, 4 Feet upwards, quite round, yet they had continued their growth many Years, and some parts of the Bark which were left in few Places not so broad as the Palm of my Hand, had a fresh Verdure, more lively than the parts of the Bark which remained above the Baring. Yet if some Incisions by Hackings be made, or if the Branches of some Fruit-Trees, (especially the Gennet-Moyle) be quite bared under a Knot near the Body of the Tree, and that Knot and bare Part be well covered with Loame, or good Mould in June, that Branch will not only survive, but will be apt to take Root and become a young Tree of speedy Growth, if cut off below the Baring, and set at a fit depth at the

end of Autumn, or about *Candlemas* rather. Where such transverse Hackings are made, or Contusions in the Bark, many Vegetables are apt to gather Knobs, and sometimes small Branches will spurt out above, and sometimes about the Part contused. To get the Gum of the Plum-Trees, I have sometimes wrenched the Branch, till the solid Timber hath crackt, and the Rind forced open in some parts, so leaving it to grow ; but forced to continue in a Posture somewhat wreathed, it hath not failed to yield me store of Gum next Summer.

Vide infra
lxix.

Dr. T. A Branch whose Bark of the breadth of about 2 or 3 Inches, is taken off round towards the bottom, in some Trees, and particularly the Lime-Tree, will live and bear Leaves for many Years, and grow as other Branches, by means of the Sap ascending thro all the Pores of the inner Coats, as was said in the 3d Observation.

6. The Juice which descends by tapping, and which maketh the Pulp or Coat of any Fruit, ascends by the Bark or Rind of the Plant, and not by the Pith. But I can affirm by many Experiments, that the Pith and the Timber have some Correspondence with the Seed of the Plant, to convey an Inter-course of the same Spirits and Nature from the Root to the Seed. Dr. B.

Dr. T. saith, That Piths are of a very different Nature and Substance ; in the Walnut is a multitude of Films, manifestly distant from one another ; in others, as in Elders and Bryars, 'tis a continued soft, loose, dry Substance.

7. The Points or Ends of the Roots being cut off, they will in proportion bleed as copiously as the Branches, and probably more, certainly longer, because there is greater plenty of Juice ascended above them, than the Branches ; and consequently more will issue by them, than by any part of the Tree higher than them. Dr. T.

8. From the latter end of *Jan.* to the middle of *May*, Trees will bleed ; those that are said to run first, are the Poplar, Asp, Abele, Maple, Sycamore : some, as Willows, and the Birch, tried by my self, are best to tap about the middle of the 2d Season ; and the Walnut, towards the latter end of *March*. They generally bleed a full Month in the whole. Mr. *Midford* of *Durham*, a very expert Gatherer and Preserver of Saps, affirms, that the Saps of the Poplar and Asp rise so briskly in *January*, that they will bleed before the end of that Month ; the Sycamore will run in hard Frost, when the Sap freezes as it drops. Dr. T.

By Dr.
Tonge. n.
43. p. 862.
n. 44. p. 880.
n. 58. p. 1199.

9. The best time of the Day for Tapping is about Noon. In the latter Season, when Sap is not very plenteous in Trees, they will neither run Morning nor Evening, nor probably at any time of the Night ; but when they are very full of Sap, and emptied but by very small Vents, the Sap may run Night and Day till exhausted, but never in large Vents. I have often observed, that when a large Walnut would yield no Sap any longer in the Body or Branches at any time of the Day, it would run longer at the Roots on the South or sunny side, than on the North or shady side, constantly governing the course of its Sap in its beginning to rise, and to stop daily at the rising and setting of the Sun.

10. Trees afford no Juice at all (that has been observed) in Autumn: But Birch-Trees bored in the Spring, so late, in respect both of the Year and Day, that they have afforded no Sap at all at the Body, have been found some time after, to have issued such plenty of Juice, as hath condensed in the Hole to a stiff Gelly.

11. Rain being scarce, the Juice will be scarcer. Plenty of Rain can only give such plenty of Sap, as the Pores will admit. And too much cold Rain may, by over-cooling, hinder the Sap, by abating from the degree of Heat necessary to the Pulsion of Sap into the Root, and to the Digestion in the Tree: which is also in watering. On this ground it seems probable, that drawing Sap constantly from Trees every Year, will not hinder their growth, in Body, Branches, Leaves, nor Fruit, to any great Prejudice; for Pulsion will still supply Juice into the emptied Pores, till their Capacity be filled. It is also possible, that Trees may grow better, and give more Fruit, if the right Art of drawing Sap be found out for that end; as some Persons grow fatter by often bleeding.

12. In the change of the Nature of a Tree, the Application of Juices is, p. 44. p. 377. in my opinion, not otherwise considerable than from the scarcity, plenty, or goodness, of the Nourishment of such Juices; not from the Taste, or Relish in them. Yet probably hot Nourishments, whether in Juices or Earths, may digest the Sap, and consequently the Fruit better in Trees of fleshy Fruit, than in others; and *vice versa*. In the mean time to change the Taste of Fruit, the probablest way may be thought not very hopeful to bore the Roots and the Body, downwards and transverse, and to fill the Holes with plenty of its own or some other Tree's Sap, in which some Aromatick Substances have been strongly infused.

13. If no Rain come to the Roots of Trees at all, nor other Moisture, they will not grow; but if the Points of the Roots only be watered, tho all the rest remain dry, (as it happens naturally in Fir-Trees) they may grow very well. For the Points of the Roots shoot out yearly a sharp-pointed tender Part, somewhat like the sharp Bud on the end of a Sprig, by which the Root not only enlarges it self in the Earth, as the Branches do in the Air, but also receives its Nourishment: And that tender Part moves it self towards the best moistened and the tenderest Earth. So that to promote the Growth of Trees, 'tis very effectual to loosen the Earth about the Points of the Roots; and there also to minister Nourishment or proper Liquors; and this in Trenches where the Amendment may remain, rather than above; throwing out the dead Mould out of the Trenches, and spreading it above to kill Weeds.

14. The Roots of Plum and Lime-Trees inoculated upon, will shoot out their Buds, as I have experimented. I fail'd of Success in the Walnut, in regard I think I had not well provided for what was necessary to keep the part inoculated from the moisture of the Earth and Rain. To make a successful Tryal, suppose in an *Alkermes-Oak*, (a delicate Tree, and difficult to be otherwise inoculated upon) let the Root to be grafted on be bared in the Fall of the Leaf, taken out of the Earth, and at convenient distance from the Body of the Tree, bow'd, and raised a Foot above the Earth; and then the Points and
Fibres

Fibres of the Root carefully laid about with fresh Earth, and water'd till they take well, and till the Root raised in the Air have a Bark like that of a Branch of a Tree; which probably it will get in the next Season of Inoculation. The Inoculation it self is made on the part raised after the ordinary way. When 'tis done, let it be carefully covered with some soft Wax, as is known, to defend it from the Rain; it is to be stop'd, and order'd in all things, as in other Inoculations.

15. The Arms of the Roots of Trees, are to be cut for the advantage of their Growth according to the proportion they have to their Head and Body; or according to the Design you have to encrease Wood or Fruit. For such Roots as are more outward, feed Wood; such as are inward, the Fruit.

16. The depth of Trees to be set, should never be below the reach of the Sun's Heat, nor the goodness of the Mould, and rather too shallow than too deep: for as much as they are apter to sink lower, than to raise themselves upwards, if they be out of the convenient reach of the Sun's heat, the cause of Pulsion and Nourishment.

17. The Seeds of Fir, Pine, &c. which bring up the Shells of their Seeds, upon the Heads of the first Shoot, will either not grow at all, or difficultly, if the blunt end be put downwards, because in that Posture it must turn it self, before it can emerge into the Air, for the Root is shot downwards at the sharp end: But it may very well grow, if set horizontally.

18. Such Trees as were mentioned in the first Observation, may grow, tho no part of the Root be in the Earth. And all such as may be propagated by short Sticks cut off at both ends, and laid in the Ground, as Mulberries, will do so. Some young Plants, if their Heads be kept moist, will live all Winter, if mild, tho their Roots be in the Air, as I try'd in Seedlings of Apples and Crabs. Their Roots set afterwards in the Spring, grew and liv'd. The reason why some Plants grow in Sticks, may be the softness of such Wood, apt thereby to receive Nourishment like a Root, and to shoot out Roots and Fibres from themselves. But in some Slips, taken from firmer wooded Trees, as Bays, a moist temperate Season is to be observed; and some Stone, or Chip of some Wood, to be closed to the end of the Slip, and set in the Earth with it, which helps its Rooting.

19. I am inform'd by a curious and intelligent Person, that the Corruption of Timber depends not upon the time of the Year, and the Ascent, or the plenty or scarcity of Sap, so much as upon the Season of the Moon or Wind. And he affirms that Timber-Trees fell'd when the Wind is in the West, especially in the old Moon, will keep them free from Grubs (as they call it) i. e. from being Worm-eaten; and on the contrary, that when cut down in an East Wind, the Worm will seize on them, in what Season of the Moon soever it be fell'd. To prevent which Corruption, 'tis advised that such Timber should be forthwith thrown into Water.

20. *Ethelbert Jay*, an ingenious and expert Planter in *Leimster*, supposeth, that the fittest time to inoculate, is presently after *Midsummer*, because, saith he, the Sap descends; but I say, because 'tis then most plentiful, and begins to jelly. The same ascribes it to the Sap ascending, to take the Bud inoculated

inoculated before *Midsummer*; and to the Sap descending, to take it after *Midsummer*. The time he limits to a few Days before *Midsummer*, and to 8 or 10 Days after it. Mr. *Austin* limits 14 Days before, and as many after, and would have the Bud unty'd after 14 Days, as I remember.

It is all one, whether the Sap be exhausted below, by being converted into Wood, Roots, and other Uses; or by Diversion, as when the Branch is cut, or the Bark opened below: The Sap in both Cases descends, or rather sinks indifferently, to supply the Defect, and heal the Wound; and so it comes to pass, that there being about *Midsummer* the greatest plenty of Sap in Apple-Trees, a Bud then inoculated will thrive, especially before *Midsummer*; for then it draws its share in the Sap ascending; and all the necessary Uses of the upper Branches being served, it partakes of the Flood of the abounding and superfluous Sap remitted to it from them.

21. My Friend informs me, that to cut off the Head of the Stock, above the inoculated Bud, will make a better Shoot, than in the usual Inoculation; if this be done a few Days before *Midsummer*.

22. If the Sap in its subsiding, be considerable in the matter of Inoculation, it seems that Inoculation will hold best and longest in Season, in the Root.

For I have observed the Sap to subside unto the Roots out of the Body at such times of the Day and Year, when in the Branches I found none to spare.

23. To make a barren Tree bear again, cherish it with Dung in Trenches, and pare and renew the Extremities of its longest Roots, and cut off the outermost and shortest, nearest the Body. Hence it may seem, that plowing helps Fruit-Trees.

24. Cross-Hackings promote Fruitfulness, cure the *Phylomania*, whereof the Reason seems to be, that (as was above intimated) outward Circles and Barks feed the Wood, and the inner only reach out to the outermost Sprigs of the last Year, to which the Fruit is appendant. For some Trees bear only on this Year's Shoot, and some only on that of the last, possibly some only on the third Year's Shoots; and cease bearing when they shoot no new Sprigs. Seasonable bearing the Roots, which they call *Ablaqueation*, probably hath the same Effect, because it hinders the Nourishment especially of the outward Coats, and of Bark, Leaves, and Suckers: But because it seems that as some Suckers or Shoots, lately sprung in outward Coats, rob the Fruit of the risen Juice; so later Roots, come from the outward parts of the main Roots, rob them also of their first Nourishment in the Earth. They ought to be pruned, as well as all Suckers and not-bearing Branches and Sprigs, every Year. For which reason also Dung and other Amendments, as was said above, ought to be apply'd in Trenches nigh to, and beyond the farthest Points of the Roots, to draw them out of the Shade and Drops. To this end, Distance and Situation is to be observed.

25. One of the best ways of obtaining the greatest store of Sap in the shortest time from the Body of any Tree is, not only to pierce the Bark, nor to cut the Body with a Chisel almost to the Pith (as some have directed) but quite through all the Circles and the inner Rind it self, on both sides of the

the Pith, leaving only the outermost Circle and the Bark on the North-East side unpierced. But this Hole is to be bor'd sloping upwards, as large as the biggest Augre you can get will make ; and that also thorough, and under a large Arm, near the Ground ; so will it not need any Stone to keep open the Orifice, nor Spigot to direct the Sap into the Receiver. This way the Tree will in short time afford Liquor enough to brew with : And with some of these sweet Saps, one Bushel of Malt will make as good Ale, as four Bushels with ordinary Water ; tho you should brew even in *March*, held the properest time for Brewing, in regard of the goodness of the Water at that Season. Sycamore I take to yield the best brewing Sap, being very sweet and wholesom.

26. To preserve Sap in the best condition for Brewing, what you gather first, must be insolated by a constant Exposure of it to the Sun in Glasses or other fit Vessels, till the rest be gathered and ready ; otherwise it will soon contract an Acidity. Having been thus exposed to the Sun, till a sufficient quantity is collected ; put into it so much very thin cut and hard toasted, but no ways burnt, Rye-Bread, as will serve to ferment it ; and when it works, take out the Bread, and bottle the Liquor, stopping it up with waxed Corks : If you bake Sage, or any other Medicinal Herbs, in such thin Rye-paste, till they be very dry, you may expect a very wholesom Drink. If you put a few Cloves in every Glas, into which the Sap runs from the Tree, it will certainly keep a Twelvemonth : But I have wondred, whilst I observ'd how speedily it drew the Taste and Tincture of the Clove. In some few Bottles I was so happy as to draw out my Cloves, with a Cloth in which I ty'd them up, in such a Season, as not to change Colour nor Taste ; and yet I preserved the Birch-Sap by that slight Fermentation, above a Twelvemonth without any Alteration, which else would have soured in a few Days.

27. Some propose Oil of Sulphur to perfume the Bottles with.

28. Spirit of Wine ferments the Juice of some Berries, and possibly may not only preserve but advance the Virtue of Saps, a little being poured on the Top of them in the Bottles, or some other oily Spirit.

29. Raisins infused in the Liquor of Birch, is one ingredient of the *Durham* Gardiner. I have been informed, that he uses Sugar : But I believe, he puts it not in till he opens a Bottle presently to be drunk, because it maketh the Liquor sparkle in the Glasse.

30. A certain Lady ferments it with Rye-Toast, not put in, but only hung over it, in such quantity, and at such distance, as may give some light Warmth, Motion and Alteration to the Surface of the Liquor.

31. I fermented some with Ale-Barm, which converted my delicate Birch Juice, kept in Bottles, into pitiful small Beer ; which I wondred at, for I knew one who used, by the Barm of Ale, to improve small Beer, and thereby to keep it the better in Bottles.

32. Honey will not mix with Cyder, tho boyl'd therein to make Meath : but after a while the Cyder lets fall the Honey, and becomes simple Cyder again.

33. Some affirm, that the Tops and Leaves of Birch decocted in the Sap will

will preserve it from souring the whole Year; and that any sort of dried Aromatick Herbs, as Sage, &c. boil'd in Beer, will keep it as well as Hops, Ling, (Heath) Broom, or Worm-wood. I had a Friend who used Bay-Leaves in his Beer and Ale.

34. The Asps run only (as Mr. Milford relates) before February; the Hop, ^{n. 58.} about Hop-Harvest, withers in April.

35. In those Trees, whose Sap seems to be of a gummy Nature when condensed, as Plums, Cherries, &c. I know no Experiment, by which any drop of Sap can be collected. And I suspect, some other Fruit-Trees to be of that Nature, whose Sap I could not draw out, at any Season, of hot or cold Weather, tho they have not been observed to yield any Gum. Perhaps there may also be some Fruit and other Trees, whose Saps are viscous, tho not gummy; and these, I doubt, will not yield any Sap to be gathered in any common or known way.

36. It is not feasible to gather all the Sap of those Trees, whose Juice is fluid and plentiful, and condenseth into a Gelly; because it seems at most Seasons of the Year to ascend imperceptibly, and that not only in the outward, but innermost Parts and Pores of the Tree, not only betwixt Bark and Wood, but betwixt every Coat of the Wood, and even thro the most solid Parts of each Coat, as Mr. Willoughby's Observations have ^{Vid. Inf.} discover'd.

37. An eminent Planter in Gloucestershire has discovered to us, that by binding the Trees round about very closely and strongly with Cords, so as to intercept what riseth 'twixt the Bark and the Body, he retards their Blossom and Bearing: And so may in some Years (when the open Weather hastening Blossoms is like to destroy the Fruit) prevent a Scarcity of forward Fruit, usually nipped by the late Frosts.

38. I kept some Sap in a large Retort of 2 or 3 Gallons, exposed Night ^{ib. p. 2075.} and Day (without any other stop than the Obligation of the Retort's Neck, and a little Paper to keep out Insects) many Months, and it contracted a Coat on its top; the Taste pleasing my Palate, I adventured to brew with it at Cyder Season, and made a good Quantity of good Cordial-Drink, with 8 Bushels of chopt Apples, brewing them like Malt with hot Water, and putting my Juices and Saps into my Water Cyder at the latter end of their boyling. I filled a Stand with it, which contained half the Quantity of the largest Rhenish Wine Vessel, viz. about 40 Gallons, as I remember. I had not half Sap in this Liquor (the greatest part of my Brewing being made with Water) yet I got 5 Gallons and more of warming Cordial and pleasant Drink for every Bushel of my Apples. If it had been all Sap, it would have been much more cordial and strong. There was in it a considerable quantity of Juice of Borrage Roots and Herbs (at that Season usually thrown out of Gardens) which Borrage-Liquor works and purges it self when tunned, and turns into an excellent clear brown Liquor. I drank my Drink in Easter following: So my Sap gathered at Spring, and brewed about Michaelmas, continued good till Easter, and after it.

39. Some affirm, that the dividing of Crab-Stock-Roots, from the Stem left in the Ground, is the best way of multiplying Crab-Stocks, or a commendable one at least.

40. 1. I have heard that a Chip of soft Wood, laid to the end of a Bay-Slip, promotes its rooting: And that Mulberry-Slips are easily propagated, set in the latter end of *January*, or beginning of *February*, in a moist Season, not in a dry *March*. Such Slips root best, if they be Suckers, and taken off with part of the old Bark; or if they be last Years Shoots, cut off from Arms, taken with some older Bark from the place where they shot out. I have set many formerly, which all thrive. I affect to propagate them for Pear, and other Stocks, namely Quinces, Medlars, Plums, to turn their Pulp and Juices red, by taking Grafts from such Trees as have been grafted on Mulberries. Perhaps the blood-red Pears and Redstreaks were thus raised at first, or may be thus propagated to advantage.

By Mr. Fr.
Willoughby
and Mr.
Wray. n.
48. P. 963.

2. 1. In Birch Trees, the Sap issues out at the least twigs of Branches, and Fibres of Roots, in proportion to their bigness.

2. In all Trees the Gravity promotes the Bleeding; so that from a Branch or Root, that bends downward, there will issue a great deal more Sap, than from another of the same bigness in a more erect Posture.

3. Branches and young Trees cut quite off when they are full of Sap, and held perpendicularly, will bleed, as we experimented in Willow, Birch, and Sycamore: And if you cut off their Tops, and invert them, they will bleed also at the little Ends. Hence one may conjecture, that the narrowness of the Pores is not the sole Cause of the Ascent of the Sap; for, Water that hath ascended in little Glass Pipes, will not fall out again by its own Gravity, if the Pipes be taken out of the Water.

4. Roots of Birch and Sycamore cut asunder will bleed both ways, that is, from that part remaining to the Tree, and from the part separated; but a great deal faster from the part remaining to the Tree. But in a cold snowy Day, the Root of one Sycamore, we had pared, bled faster from the part separated; and ten times faster than it did in warm Weather before.

5. In Birches the Sap does not issue out of the Bark, be it never so thick, but as soon as ever you have cut the Bark quite thro, then it first begins to bleed.

6. The Bark being quite pared off above an Hands-breadth round, about several Birches, did much abate the bleeding of the Trees above the pared places, but did not quite stop it.

7. The Sap doth not only ascend between Bark and Tree, and in the prick Circles between the several Coats of Wood; but also thro the very Body of the Wood. For, several young Birches being nimbly cut off at one blow with a sharp Axe, and white Paper immediately held hard upon the top of the remaining Trunk, we stuck down Pins in all the points of the Paper as they appeared wet; and at last, when the most of the Paper became wet, taking it away, but leaving the Pins sticking, we found them without any

any Order, some in the Circles, and some in the Wood between. And to confirm this further, we caused the Body of a Tree to be cut off aslope, and then cut the opposite side aslope likewise, till we brought the top to a narrow Edge; ordering the matter so, that the whole Edge consisted of part of a Coat of Wood, and had nothing of a prick'd Circle in it, which notwithstanding, the Sap ascended to the very top of this Edge, and wetted a Paper laid upon it.

8. To find out the Motion of the Sap, whether it ascended only, or descended also, we bored a hole in a large Birch, out of which a Drop fell every 4th or 5th Pulse. Then, about a Hand's-breadth just under the Hole, we saw'd into the body of the Tree, deeper than the Hole: Whereupon the bleeding diminish'd one half; and having saw'd just above this hole to the same depth, the bleeding from the hole ceas'd quite; and from the saw'd Furrow below decreased about half: And it continued bleeding a great while after at both the saw'd Furrows, the hole in the middle remaining dry. We repeated this with much the like Success upon a Sycamore.

9. Some Trees of the same kind and age bleed a great deal faster and sooner than others; but always old Trees sooner and faster than young.

10. A Wound, made before the Sap rises, will bleed when it doth rise.

11. While we were making these Experiments, the Weather changed from warm to very cold; whereupon the bleeding in the Birches, which begun to abate before, ceas'd quite: But all the Sycamore and Walnut-Trees, we had wounded, bled abundantly, (some whereof bled not at all, and those that did, did so but slowly) and so continued Night and Day, when it froze so hard, that the Sap congealed as fast as it issued out. The Cold remitting, the Birches bled afresh, the Sycamores abated very much, and the Walnut-Trees quite ceased.

12. We pierced two Sycamores on the North and South sides, and both of them from equal Incisions bled a great deal faster from the North sides, than the South; which is consonant to the preceding Experiment.

13. We set several Willows with the wrong Ends downward, and cut off several Bryars that had taken Root at the small Ends. This 29th of May 1669. the Willows have shot out Branches near two Foot long; and from the top of the Sets, which were a Yard high, the Bryars have also grown backwards, from that part which we left remaining to the Roots at the lesser Ends; they have great Leaves, and are ready to flower.

14. Dr. Tonge found, by his Experiments in the Roots and Branches of Trees, that not only cold Weather but cold Wind and Sunsetting stopped or abated the Motion of Sap in the Sycamore: But his Experiments were made in February, and ours towards the end of March. The Cold which caused that increase of the bleeding in the Sycamore and Walnut, happened upon the 23, 24, 25, 26. of March; and one Sycamore, which ceased to bleed from the 11th of the same Month, bled afresh copiously from Wounds that had been made so long before. The Buds before the Cold, were just ready to open into Leaves, and the Sap had begun to coagulate above a Fortnight before. In January 1672 making Incisions in the Sycamore and com-

By Mr. Willeughby; n.
57. p. 1165.

mon Maple immediately upon the relenting of the first Frost, we found that they both bled, and faster, as the Weather grew hotter; nor did the succeeding Cold promote, but rather hinder their bleeding. So that the learned Dr. doth most ingeniously conjecture, that the Ascent of the Sap in Trees, depends upon a certain Degree of Heat, sufficient to raise, but not to coagulate their respective Juices. In those Months, wherein the Heat ordinarily falls short of that Degree, an accidental Heat or Warmth of Weather promotes the bleeding; but in those Months, wherein the ordinary Temper of the Air exceeds that Degree, an extraordinary fit of colder Weather makes them bleed again.

15. In Walnut Trees, we never yet found, that Heat promoteth their bleeding, but always Cold. From a Wound made in a Walnut Tree in *January*, and the beginning of this present *March 16 $\frac{2}{7}$* , in mild Weather, nothing issued; but the Weather changing and growing colder, it bled plentifully.

16. *March 11. 166 $\frac{2}{7}$* . Roots of Birch, great and small, bled both ways; and about the same time, Sycamore Roots also. The same Birch which first began to bleed, *March 3. 16 $\frac{2}{7}$* . bled three Weeks sooner the Year before.

17. It was observed in *Autumn 1669* by Mr. *Mart. Lister*, that upon the first Frost, which happen'd in *November*, a Sycamore bled copiously; so that the Sap cannot be said to rise in *January*, but immediately after the Fall of the Leaf, in this Tree.

n.58.p.1199. 18. After the Leaves were explicated in the Year 1670, we observed the Sycamore, after several frosty Nights, to bleed afresh in the Morning, soon after Sun-rising, when it had ceased several Days before; tho this must not be understood of all Sycamores, but of some only that are more sensible and observant of the Weather.

April 3, and *4*, all the Sycamores quite ceased.

The 5th being after a white Frost, they began to bleed about 8 a Clock, and ceased towards Noon.

The 9, 12, 13, 15, they bled again.

The 16, they bled not, it being rainy, and the Sun not shining.

From the Observations we have hitherto made, we think it may be certainly inferr'd, that a Morning Sun after a Frost, will make all the bleeding Tribe bleed afresh, tho they had before ceased, and that this new bleeding towards the latter end of the Season commonly ceaseth before Noon. Possibly some may bleed after a Frost, yet further in the Summer.

19. I observed in *August*, a copious and spontaneous Exsudation, very like bleeding, of a viscous yellow Juice, out of the Buds of a black Poplar.

20. Our Walnut-Trees bleed here at *Middleton* in *Warwickshire* in *January*.

By Dr. Tonge. 21. I am very much confirmed in my Apprehensions, that Trees
n.68.p.2070. and other Plants, if we could contrive them, as I have (but slenderly) projected in my Sap, wiser to that purpose, would far better indicate the Altera-

Alteration of Weather, as to Heat, Cold, Moisture, Drought, than any Weather-Glasses I have yet experimented. For my Weather-Glass continuing at one and the same station in a manner all this Day (*April 13. 1670*) my Trees have altered their Temper so much, that 24 of them that ran tolerably this Forenoon, yield not a Pint of Sap this Afternoon; and tho one of them ran most part of the Day, the rest ceased about one or two of the Clock in a fair, clear, sun-shiny Season, retarded (so far as I could observe) only with a Western Wind, tho that be reputed mild and cherishing.

These Trees ran above 2 Quarts in the Morning, the Weather-Glass continues the same, viz. about 11 Inches Water these two Days. *Thursday 14.* it was $9\frac{1}{2}$ only.

Friday 15. My Weather-glass at Noon was advanced from 9 to $10\frac{1}{2}$, yet the Quantity of Birch-Water this Day exceeded my former from these Trees, for I had above $2\frac{1}{2}$ Quarts before Noon.

But for Cold, I find that the Air, when any whistling Blast of cold Wind stirs, stays my Birches.

Saturday, April 16. These 24 Birches began to run presently after Sun-rise, and ran about 3 Quarts, and ceased about 2 a Clock after Noon, having till then continued to run.

Sunday 17. It rained so, that we could make no Observations what Sap these Trees might spend; neither did Rain and all amount to much above a Gallon and a half. *Monday 18.* they ran until Noon. *Tuesday and Wednesday* the 19 and 20, wherein was expected greater Store of Sap, after the Rain the Trees spent not a Drop.

Saturday, April 23. My Weather-Glass stood at $7\frac{1}{2}$, it being a rainy and boisterous Morning, the Rain not allaying the Wind. At 9 a Clock of that Forenoon, my Birch-Water worked in the Barrel, *per se*; which seems to verify Mr. Souton's Relation from his Brother, a Swedish Merchant, importing that Birch-water in Sweden worketh alone (perhaps collected in great Quantity:) Only I put a few Cloves into my Sap, boil'd to a third or less, it keeps well, especially when boil'd with the Buds or Sprigs of the same Tree, as I have been inform'd.

April 16, 17, 18. In the Year 1670, Birch-sap mixed with Rain-water at the Tree, fermented with Rosemary-sprigs, steeped in Spirit of Wine; which warmed the Stomach as strong Wine, and pleased the Palate; tho the Taste in the Mouth was somewhat waterish.

22. We find that Branches of Willow, Birch and Sycamore, cut off and held perpendicularly, will bleed without tipping, and that the cutting off of their Tips does not sensibly promote the bleeding.

By Mr. Fr.
Willoughby
n. 70. p. 2125.
Vid. inf.

We doubt not of Mr. Lister's Diligence and Veracity, and wonder our Experiments should differ. The Sycamore bleeds upon the first considerable Frost, after the Leaf is fallen, as it did plentifully *Nov. 16. 1670.* And both that Walnut and Maple bleed all Winter long, after Frosts, when the Weather relents, and the Sun shines out; but Walnut and Maple begin not so soon as the Sycamore. The Birch will not bleed till towards the Spring, *An.*

1671.

167¹. it began something sooner than ordinary, about the beginning of Feb.
 Ib. p. 2142. 23. In a very sharp Frost the bleeding is stop'd till the Weather begins to change, but in a moderate Frost, tho it stop in the Night, yet in the Day-time, if the Sun shines out, the Trees will bleed tho the Frost continue. What we said formerly, that Cold did not promote, but hinder bleeding, we find holds true if the Cold be without Frost.

Ib. p. 2126. 24. We cut off pretty big Branches of Birch, and having tip'd the Ends, inverted them, and fastned a *Limbus* or Ring of soft Wax to the great Ends, which we held upwards, making with the Plane of the End, a Vessel of about an Inch deep, whereinto we poured Water, which in a few Minutes sunk into the Pores of the Wood, and running quite thro the Length of the Branch, dropped out of the Ends considerably fast, continuing so to do as long as we poured on Water. The like Experiment we made by fastening such Rings of Wax to the lesser Ends, and pouring in Water, which ran thro the Wood, and drop'd out of the greater Ends as fast or faster: This we tried once upon a Sycamore without success; but afterwards I made trial both upon Sycamore and Walnut, and found that Water runs thro both, but nothing so fast as thro Birch.

By Dr. Lister, n. 68.
 p. 2067. n.
 70. p. 2120,
 2126.

3. 1. About the Beginning of Nov. 1669, I pierced a Sycamore growing in a sandy Soil at Nottingham, the turgescence of the Buds inviting me there-to, and engag'd my keeping a Journal till the latter End of March following: from which Journal I think I may note, 1. That the wounded Sycamores never bled, neither in November, nor December, nor January, nor February, nor March (which yet they did above 40 several times, that is, totally ceasing, and then beginning a-new) unless there preceded a sensible and visible Frost; for I had no other way of recording the temper of the Air. 2. That the Frost did not always set a bleeding the Wounds they found made before they came, tho sometimes they did; but upon their breaking up, or very much relenting, the Wounds, either made at that Instant of time, or made many Months before, did never fail to bleed more or less. 3. That particularly upon the breaking up of the 2 great and long Frosts (the first of which happened that Year in that Country to be on the 3^d of January, the second about the 12, 13 and 14 of Feb.) all the Wounds ran most plentifully, so that such times may be looked upon as the most proper Season of gathering great Quantities of Juice from this Tree.

2. In May 1670, I wounded some Sycamores in Craven, but they did not bleed, neither the remaining part of that Month, or the following Months of June and July; but had the Orifice of the Wounds made with a small Augre, in a manner quite grown up, and would scarce admit a Pigeon's Feather. Wherefore the 30 of July, I cut out a square Piece of about 2 Inches of the Bark of a large and well grown Sycamore about my height, in the Body of it. This Wound began to run next Morning about 9 a Clock, so as to drop, and that was all, and dried up by 11 in the Morning; the like Cut I made in a young Sycamore, the 8th of August, which in like manner bled the next Morning, but stopp'd before 9 a Clock. It did so for 2 or 3 Days; but then totally dry'd.

3. *November 1, 1670.* Here at *York* I pierced and otherwise wounded 2 Sycamores growing in a wet Clay, but they never stirr'd till the beginning of *February* following. Yet Mr. *Wray* hath assured me, that those of *Warwickshire* bled the 16th of *November* copiously, and afterwards the Walnut-tree also.

I am apt to think that the Sap in all parts of the Tree, at the times of this anomalous Bleeding, is some ways notably altered in its Temper and Consistence: And this Bleeding by stress of Weather may in these Trees probably be look'd upon as a Violence done to their Natures from an unkind Climate, considering the Walnut and Sycamore as Strangers, and not Natives of *England*. 'Tis indeed true, there are many sorts of *English* Plants, which will bleed in Winter; but note also, that such Plants never refuse to do so at any time of the Year, no more than a Man, who may bleed a Vein when he pleaseth.

4. *Feb. 1. 1670-1,* it froze, the Wind at *North*, the Frost and Wind continued (some little Snow and Rain falling) the 2, 3, 4, 5, 6, until the 7 in the Morning, when the Wind came about to the *South-East*, and the Weather broke up apace. The Sycamores bled not all this while; but the 7th about Noon all Trees of that kind bled very freely, both at the Twigs and Body, and I struck above a Dozen.

At this same critical Season, I also struck the Hawthorn, Hazel, Wild-Rose, Gooseberry-bush, Apple-tree, Cherry-tree, Blather-nut, Apricock, Cherry-Laurel, Vine Walnut; yet none bled but the last named, and that faintly in comparison of the Sycamore.

Feb. 11. All was here covered with a white Frost betwixt 9 and 11 in the Morning.

The Weather changing, I made the Experiments which follow, upon the Sycamore, Walnut, Maple. A Twig cut asunder would bleed very freely from that part remaining to the Tree; and for the part separated, it would be altogether dry, and shew no Signs of moisture, although we held it some pretty time with the cut End downwards; but if this separated Twig was ever so little tipp'd with a Knife at the other End, it would forthwith shew Moisture at both Ends: the same Day, late in the Afternoon, the Weather very open and warm, a Twig cut off in like manner, as in the Morning, would shew no Moisture at all from any part. But I have since been convinced, that 'twas rather some unheeded Accident which caused this new Motion of the Sap, than merely the striking off their Tops. Ib. p. 2128.

5. Because Sap is said to ascend from the Root; when it is found, to move in tapping, I lopp'd off certain Branches of a Sycamore, the Morning betimes of a hard Frost (*Feb. 21*) before they would bleed, or shew any Sign of Moisture. And not willing to wait the change of the Weather, and the Sun's Heat, I brought them within the Air of the Fire; and by and by, as I expected, they bled apace, without being sensibly the warmer. Ib. p. 2123.

This Experiment repeated, afforded me divers Phenomena, which follow; and prov'd almost an universal way of bleeding all sorts of Trees, even those which of themselves would not shew any Signs of Moisture.

1. Poles of Maple, Sycamore and Walnut, cut down in open Weather, and brought within the warmth of the Fire, did bleed in an Instant. Also Willow, Hazel, Cherry, Wood-bine, Blather-nut, Vine, Elder, Barberry, Apple-tree, Ivy, &c. Whicking and Egge-berry Tree, (*i. e. Padus Theophrasti*) tried in the same manner in Craven.
2. Briar and Raspberry-rods were more obstinate; Ash utterly refused, even heated hot.
3. Branches, that is, Poles with their Tops entire and uncut, bleed also when brought to the Fire side; but seem not so freely to drink up their Sap again when inverted, as when made Poles.
4. The same Willow-poles left all Night in the Grass-plot, and return'd the next Day to the Fire-side, bled afresh.
5. Maple and Willow Poles bleed and cease at pleasure again and again, if quickly withdrawn and ballanced in the Hand, and often inverted to hinder the Falling and Expence of Sap; yet being often heated, they will at length quite cease, tho no Sap was at any time sensibly lost. And when they have given over bleeding, that is, shewing any Moisture, by being brought within the Warmth of the Fire, the Bark will yet be found very full of Juice.
6. An hard Ligature made within a quarter of an Inch of the End of a Wood-bine Rod did not hinder its bleeding at all, when brought within the Warmth of the Fire.
7. Maple and Willow-Poles, &c. quite bared of Bark, and brought to the Fire, will shew no Moisture at all in any part.
8. One Barberry or Pipridge-Pole, bared of its Bark brought to the Fire, did shew Moisture, from within the more inward Circles, tho not any from the outward.
9. Maple and Willow-poles, &c. half bared of Bark, would bleed, by the Fire, from the half only of these Circles, which lay under the Bark.
10. Maple and Willow-poles, split in two and planed, would not shew any Moisture on the planed Sides, but at the Ends only.
11. A Pole of Ivy did of it self exsudate and shew a liquid and yellowish Resin from the Bark and near the Pith; but when brought to the Fire-side, it bled a dilute, thin and colourless Sap from the intermediate Wood-Circles.
12. A Pole of Willow (for Example) bent into a Bow, will ouse its Sap freely, as in bleeding either spontaneously or by the Fire.
13. One or both Ends of the Pith of a Willow-Pole, seal'd up with hard Wax, will yet freely bleed by the Warmth of the Fire.
14. March 23, 167 $\frac{1}{2}$, was the greatest Frost and Snow we have had this Winter in these parts about York, when some Twigs and Branches of the very same Willow-tree as formerly, and likewise of many other Willow-trees, taken off that Morning, being brought within the Air of the Fire, would shew no Moisture at all; no not when heated warm, and often and long turned.
15. Mar. 24. The same Willow-branches, which the day before would not bleed, and were thrown upon the Grass-plot all Night, did, both they and other

new cut down, by the Fire-side freely shew Moisture, and bleed in the Morning upon the breaking up of the Frost.

16. Ash-Poles and Branches that Day, and the Day before, would by the Fire be no more moist, than when I formerly tried them.

17. The same Morning, a Twig of Maple which had had the Top cut off the 7th of Feb. (and which then bled) being quite taken off from the Tree, and brought within the Air of the Fire, and held with the formerly cut End downwards, did not run at all at that End; but held on in that Posture, it did run apace at the other new cut End uppermost, so as to spring and trickle down.

Note, That this doth well agree with my Experiments made the Year before at *Nottingham*, where I observ'd Wounds of some Months standing, to bleed apace at the breaking up of every hard Frost. For in these Parts there hath been no hard Frost this Year; not comparable to that Year. Again, those *Nottingham*-Trees I wounded in the Trunk, and they stood against a Brick-Wall, and the Wounds were on the side next it; and besides had Horse-dung stopt in all of them, for some Reasons, which things did undoubtedly defend them much from the Air and Winds, and kept the Wounds still green and open; whereas the Tops of these Maple-twigs spoken of in the last Experiment, were exposed in an open Hedge to the Air and Winds; as also the 2 Sycamores here at *York*, mentioned above to have been Wounded in *Nov.* 1670. and not to have shew'd any signs of Moisture, for that very Cause, that they were not fresh struck at Bleeding Times.

LXI. I am inclined to think, that there is some kind of Circulation of the Juices of Vegetables; 1. Because I find, that all the Juice of a Plant is not extravasate and loose, and like Water in a Sponge, but that there are apparent Vessels in Plants analogous to Veins in Animals, which thing is most conspicuous and clear in such Plants, whose Juice is either white or red, or Saffron-coloured; for instance, in each kind of Juice we propose *Lactuca Attractilis*, and *Chelidonium majus*. 2. Because that there are very many Plants (and these last named are of the Number) whose Juice seems never to be at rest, but will spring at all times, freely as the Blood of Animals, upon Incision.

The way of Ligature by metalline Rings, is an Expedient I have not used; but other Ligatures I have, upon a great Number of our *English* Plants, not without the Discovery of many curious *Phænomena*. The success of an Experiment of this Nature upon *Cataputia minor Lobel.* was as follows; I tied a Silk-thread upon one of the Branches of this Plant as hard as might be, and not break the Skin. There followed no greater Swelling that I could discern, on the one side of the Silk than on the other, altho in often repeating the Experiment, some Silks were left Hours and Days unloosed; and yet the Dimple which the Thread had made in the yielding Branches, had a little raised the immediate Sides, but both alike. The Plant in like manner would bleed very freely, both above and under the Tye. This was also, I thought, very remarkable, amongst other things, in this Experiment, that

The Circulation of Saps, by Dr. M. Lister, n. 70. p. 2122.

in drawing the Razor round about the Branch just above or below the Tye, the milky Juice would suddenly spring out of infinite small Holes, beside the made Orifice, for more than half an Inch above and below the Tye: which seems to argue, that tho there was no Juice intercepted in appearance from any Turgescence, as in the Process upon the Members of a *sanguineous* Animal, yet the Veins were so over-thronged and full, that a large Orifice was not sufficient to discharge the sudden *Impetus* and Pressure of a someways streightned Juice.

*The Descent
of Sap in
Winter, by
Mr. Rich.
Reed, n. 70.
P. 2129.*

LXII. 1. To prove that the Sap does descend in Winter, I have observed, that the Graft hath influence either to corrupt or to heal the Stock: nay, farther, to alter and change the very Nature and Way of the growing of the Root in the Earth, which I cannot see how it should do, but by sending down its Sap thither. I have by certain Observation found, that Crab-stocks grafted with some sorts of Fruits, which the Soil liketh not, they, not the Soil, will (not one or two, but all of that sort) canker, not only in the Graft, but the Stock also; which if you graft again, upon the former Graft, with a Fruit liking to the Soil, will all heal, and so become Trees. And further, certain it is by my Observation, that 20 Pear-stocks being wild, grafted young with the same sort of Pear, and 20 with another, the Roots of each of them of one sort will grow alike, and so those of the other. Generally, those that naturally grow high, as the Bare-Land-Pear, root deep, and all do so: Those whose Heads are bushy and thick, as the *Summer-Bonchrestein*, their Roots run wide, and are matted below, and all are so. This Diversity of the Way of growing of the Root, must be by grafting; and could not be but by the intercourse of Sap, which it receiveth from the Graft; and that cannot be, but by the return of Sap.

*By Dr. J.
Beal, n. 71.
P. 2144.*

2. 'Tis no wonder if the Effects which Mr. Reed mentions do follow from that Correspondence in all Parts of the whole Plant, which is by me acknowledged, especially, since by the Leaves and all the Pores in the Branches and Body, the Plant draws a kind Sustenance from the Sun, Air, and Dews, as by the Roots from the succulent Soil. And as the Channels, which I may call the Conduits and Strainers, of several Stocks, and Coyns do differ, so may some Change of the Liquor be made by several kinds of Distillation. And from the fore-noted Difference of Stocks, and the differing Grains of the Roots and Timber, as also from the differing Leaves, if accurately inspected, and consider'd, we may in time perhaps discover some particular Causes of the differing Sap, Fruit and Blossoms.

'Tis about 15 Years since I published a Hint, how to discover by the Colour, Figure, Tenderness and Asperities of the Leaves of young Apple-Plants and Crabs, first appearing in the Spring, which Plant would yield the more delicate, and which the more austere Fruit and Liquor, to several kinds and degrees of Delicacy and Austerity, Flatness and Insipidness, and

and Vigour and Briskness. And this, I think, allows a Consideration for some Efficacy, or Sign, at least, of Change or Operation in the Descent of Sap. But as far as I dare, or did, deny the Descent of Sap, I meant it in the vulgar Sense of that Expression, viz. the main Quantity of Sap which ascends in the Spring, and is gradually hardened into Leaves, Blossoms, Fruit, Timber; in such manner as the *Offification* in young Animals, is described by Dr. Kerckringius. *Anthrop. Ichn.* 'Tis a large Quantity of Sap, which is expended on the Fruit and Growth of some Trees, or Acorns, Walnuts, Chesnuts; and this returns not to the Root in Winter: Yet conflicts well with the Sentiment of the Circulation of the Sap, which in some Seasons may run the round more swiftly than in other.

LXIII. 1. Some Years ago, I made a few Observations concerning the Veins, or such *Ductus's*, as seem to contain and carry in them the noblest Juices of Plants; and I am of Opinion that they will prove Vessels analogous to our humane Veins. Those Parts of a Plant, which *Pliny* calls by the names of *Vena* and *Pulpa*, are nothing else in my opinion, but what Dr. Grew calls Fibres and Insements, or the lignous Body interwoven with that which he takes to be the cortical, that is, the several Distinctions of the Grain. But that these Vessels are not any of the Pores of the lignous Body (to use the Doctor's Terms) is plain in a transverse Cut of *Angelica Sylvestris magna volgatio*, J. B. for example; the Veins there very clearly shew themselves to an attentive View, to be distinct from Fibres, observable in the *Parenchyma* of the same cortical Body together with themselves; the milky Juice still rising besides, and not in any Fibre. Also in the like Cut of a Burdock in June, the like Juice springs on this and on that side of the *Radix* of the woody Circle, that is, in the cortical Body and Pith only. Again, where there is no Pith, there is none of this Juice to be observed, and consequently none of these Veins; as in the Roots of Plants, and Trunks of Trees; but ever in the Bark of either. These Particulars are plainly observable in the *Spondilium*, *Cicutaria*, many of the Thistle-kind, &c.

Further, neither are they probably of the Number of the Pores, described by Dr. Grew, in the cortical Body, or Pith: Not surely of those Pores extended by the Breadth, because the Course of the Juice in these Vessels, is by the Length of the Plant; as I have sometimes very plainly traced in the Pith of a dry'd Fennel-Stalk, following them by Dissection quite thro the Length of the Pith. It remains, that if Pores, they are of those Pores of the cortical Body, that are supposed to be extended by the Length thereof; which yet seems (to me at least) not enough: But we think them Vessels invested with their own proper Membranes, analogous to the Veins of our humane Body; for these Reasons, 1. Because they are to be found in the Pith, and sometimes in the cortical Body of a Plant, not included within the common Tunicle of any Fibres, as is above noted. That Fibres, or the seminal Roots, are clothed, is most plain in some Plants, as in

Veins in
Plants ob-
served by D.
M. Lister,
n. 79. p. 3052

Vid. *supra*
 Sect. LXI.

Fern and *Geranium Batrachoides*; the Fibres of the former are coated, at least in some Parts of the Plant, with a black Skin, in the latter likewise with a red one. And in these cases, had they not, I say, their own proper Membranes, we see no cause why the very porous and spongy Body of the Pith, and *Cortex*, should not be in all Places fill'd alike with the Juice, and not rise (as most plainly it doth) in a few determinate and set Places only, that is, according to the Position and Order of these Vessels. 2. Again, the Experiment I made concerning the Effect of a Ligature on *Cataputia minor Lobel. viz.* The sudden springing of the milky Juice out of infinite Pores besides the Incision, (the Cause of which *Phænomenon* I take to be the dissected Veins impetuously discharging themselves of part of their Juice within the porous *Parenchyma* of the Bark;) whence it is probable, that if there was no coated Vessel to hold this milky Juice, we might well expect its springing upon the bare Ligature, as when we squeeze a wet Sponge, the external Cuticle of the Plant, as this Experiment shews, being actually perforated.

In the next place, it is very probable, that these Vessels are in all Plants whatsoever. For, as it is truth-like of all the other substantial Parts of Plants that they are actually in, and common to all Plants, tho specified by divers Accidents in Figure and Texture; so of these Veins, which tho they be discernable mostly in those Plants where they hold discoloured Juices, yet we may very probably think, that they are not wanting, where the Eye finds not that Assistance in the challenging of them. And in these very Plants, where they are least visible, there is yet a time when they are, if not in all, yet in some parts of these Plants, plain enough to the naked Eye. The tender Shoots of the greater and lesser Maple in *May* are full of a milky Juice, *viz.* the known Liquor of these Veins. Again to this purpose, if you apply a clean Knife-Blade to a transverse Cut of the like Shoots of Elder, the gummy Liquor of these Veins will be drawn forth into visible Strings, as is the nature of Bird-lime, of the Bark of Holly, or the Milk of *Cataputia minor Lobel.* Further, the Leaf-stalks of our Garden-Rhubarb do sometimes shoot (by what Accident we enquire not here) a transparent and very pure chrySTALLINE Gum, tho the Veins that held this gummy Juice, are by no ordinary means visible in them; and yet by comparing the Nature and Properties of this Gum, with that of the Gums of other Vegetables, we cannot doubt but this Gum Rhubarb is the Juice of those Veins, as well as we are assured, the Gum of other Vegetables to be of theirs, by the same comparative Anatomy. Lastly, we think, that even Mushrooms, that seemingly inferior and imperfect Order of Vegetables, are not exempt and destitute of these Veins, some of them yielding a milky Juice, hot and fiery, not unlike some of the Spurge-kind, or *Euphorbium.*

The primary use of these Veins is, in my opinion, to carry the *Succus nutritius* of Plants; because where they are not, there is no Vegetation: as it is seen if an engrafted Branch or Arm be bared and stripped off the Clay, &c.

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in *June*, all the Course of Vegetation will appear to have been made only by the Bark, and not by the Wood, that is, in the Place only where these Veins are. A secondary Use is the rich Furniture of our Shops: For, from these Veins only it is, that all our vegetable Drugs are extracted, and an infinite more might be had by a diligent Inquiry, and some easy means which I have not unsuccessfully put in practice.

To the foregoing Observations I shall here add others of later Notice; as the Skin of a Plant may be cut sheer off with Part of the spongy *Parenchyma*, and no signs of milky Juice follow, that is, no breach of a Vein: Again, we have stript the Plant of its Skin, by pulling it up by the Roots, and exposing it to the wet Weather, until it became flaccid as a wet Thong, without any Injury to the Veins, which yet upon Incision would freshly bleed. These Experiments make against the general Opinion of one only Sap, loosely pervading the whole Plant, like Water in a Sponge.

In the transverse Cuts of Plants, we see as it were a certain Order and Number of the bloody Orifices of dissected Veins.

We observe also in a Leaf, which we take to be the simplest Part of a Plant,

1. That the Veins keep company with the Ribs and Nerves (as we vulgarly call them) and are distributed into all the Parts of the Leaf, according to the Subdivisions of those nervous Lineaments, and are disposed with them into a certain Net-work; whether by Inosculations or bare Contact only, we pretend not to determine.

2. That in a transverse cut of a Leaf, the middle Fibre, or Nerve, for example, seems to yield one big Drop of a milky Juice, springing as it were from one Vein; yet the Microscope plainly shews us, that there are many Veins which contribute to the making up of that Drop.

3. That if a Fibre, or Nerve, be carefully taken out of the Leaf, the Veins will appear in it, like so many small Hairs, or Pipes, running along, and stripping the Nerve.

4. That those many Veins are all of an equal bigness, for ought we have yet discerned to the contrary.

5. That tho we seem to be more certain of the Ramifications of the Fibres, wherein these Veins are, yet we are not so, that those Veins do any where grow less and smaller; tho probably it may be so. That which makes us doubt it, is the exceeding smallness of these Veins already; even where we might probably expect them to be Trunk-Veins, and of the largest Size: And being there also in very great Numbers, and running in direct Lines along the Fibre, we guess that one or more of them may be distributed and fall off on either hand, with the Subdivisions of the Fibres, and not suffer any Diminution in their Bulk.

6. That we cannot discern any where, throughout the whole Plant larger or more capacious Veins, than those we see adhering to the Fibres of the Leaves; which do also appear, from comparing the bleeding Orifices in a transverse Cut. I have found it a difficult and laborious Task to trace and unravel them, throughout the whole Plant.

Our

Our Opinion is, that these Veins do still keep company with their respective Fibres. And as all the Fibres of the Leaf are joined in the Stalk of the Leaf, and that Stalk explicated in clothing the Twig or Stem of the Plant (which we take to be the Reason of the orderly breaking forth of the Leaves) so do we think of the Veins, their perpetual Companions.

And as we have said, the Fibres of the Leaves are joined in the Twig; so are those of the Twigs in the Branches; those of the Branches in the Trunk or Body of the Tree. The like also in an inverted Order we seem to observe in the several Coats and Ramifications of the Root. This the several Circles of bleeding Orifices in transverse Cuts, seem to confirm.

But moreover in the Roots of Plants, if a simple Coat be separated and exposed betwixt your Eye and the Light, the Veins appear to be strangely entangled and implicate, and not in the same simple order as in the Leaves. The like we think of the Bark of the Bodies of Trees, which we cannot distinguish from the Roots of Plants: Tho there is indeed, something (at least at certain Seasons of the Year) in the Root, which is not to be found in any part of the Plant besides.

From what has been said, it may be well doubted, whether there is any *Sinus*, or common Trunk, into which all the Veins are gathered: But rather, that there are a Multitude of equally big Veins, each existing apart by it self. We indeed have found it very difficult, so to exhaust the Plant of its milky Juice as to kill it, tho we have given it very many Incisions to that purpose. Divers other Instances there are, which favour the Discontinuance of the Veins, and the little Relation and Intercourse they have with one another; as one Branch of a Tree having fair and well grown Fruit, before the other Branches of the same Tree and Fruit blossom, or have Leaves; from the different Situation and other Circumstances of Culture, the indefinite and perpetual Growth of a Tree, the *Cyon* governing, &c.

The Substance of these Veins seems to be as truly membranous, as the Veins of Animals. A Leaf will not give way and be extended, but the Veins in a Leaf, if freed of all the woody Fibres, will be stretched out to one third Part at least, and vigorously restore themselves again, just like a Vein, Gut, or any other membranous *Ductus* of an Animal. Again, these membranous Pipes are exceeding thin and transparent, because they suddenly disappear, and subside after their being exhausted of their Juice; and particularly, in that we see the Liquor, they hold, quite thro them, no otherwise than the Blood thro our Veins; or (in *Chelidonium majus*, for example) a Tincture of Saffron in Chrystalline Pipes.

In the keenest Frost, which happened the other Winter, we dissected the frozen Leaves of the Garden Spurge. Here we observed, that all the Juice (besides that which these Veins hold) was, indeed, frozen into perfect hard Ice, and to be expressed out in the Figure of the containing Pores; but the milky Juice was as liquid as ever, tho not so brisk as in open Weather. This Experiment we take to be good Proof of the Perfection of this milky Juice, and that it hath within it self so great a Degree of Fermentation, that it preserves it self, and consequently the whole Plant, from the Injuries of
the

the Weather : that is, the Plant owes its Life to it. Thus we have seen Insects (as Hexapode-Worms, &c.) lie frozen upon the Snow into very Lumps of Ice ; and yet put under a Glass, and exposed to the Warmth of the Fire, they quickly recovered their Legs, and Vigour to escape ; which we think could not be, unless the vital Liquor of their Veins, as in this instance of Plants, had been untouched, and little concern'd in the Frost. Further, we hence also urge the different Uses as well as Natures of these Juices, and look upon the frozen Icicle, or that copious dilute and limped Sap, as alimantal ; the milky and not frozen Juice, as the only proper venal.

As to the Motion of these Juices, these things are certain :

1. That the milky Juice always moves and springs briskly upon the opening of a Vein : The limpid Sap, but at certain Seasons, as it were by Accident, and not, as I judge, from any vital Principle, or Fermentation of its own.

2. The venal Juice hath a manifest intestine Motion, or Fermentation, within it self. Witness, besides what hath been just now said of it, its contributing, and the long continuance of, that Motion to the most insensible of Liquors ; and likewise its thick and troubled Bleeding, like the rising of Yeast, which yet in a few Hours after drawing, falls, and the Juice becomes transparent, as the Gum of the *Virginian Rhus*, &c.

We think indeed, (according to the Knowledge we yet have of the Parts of Plants) that these Juices move by a far different Contrivance of Parts from that of Animals ; not yet here discovering any uniting of Veins into one common Trunk, or Pulsation, no sensible stop by Ligature, no difference in Veins, &c. All which Difficulties, notwithstanding, may, I hope, in time be happily overcome, and the Analogy betwixt Plants and Animals be in all things else, as well as in the Motion of their Juice, fully cleared.

There seem to be in Plants manifest Acts of Sense : We instance in the sudden shrinking of some Plants, the frequent closing and opening of Flowers, the critical erecting of the Heads of Poppies from a pendulous Posture, and particularly the Vermicular Motion of the Veins when exposed to the Air. Again, the Veins of Plants may indeed be different, tho at present we cannot tell wherein they are so ; the Arteries within our Heads are hardly to be known by the Eye from the Veins. Further, there are natural and spontaneous Excretions or venting of superfluous Moisture in Plants, visible and constant, in the Crown Imperial, *Roseella*, *Pinguicula*, &c. As to the Ligature, as it hath been hitherto applied by us, it is not to be relied on for the discovery of this Motion ; the Veins only of Plants being the Parts probably distendable.

Lastly, We must either take that away from the other Reasons given of the necessity of the Circulation of the Blood in Animals, viz. The hindring of its breaking and clodding ; or we must grant the same Motion to the venal Juice in Plants. We have undeniable Experiments to shew, that the venal Juice of Plants and the Blood of Animals agree in this, That they both, when they are once drawn from their respective Veins, do forthwith
break

break and coagulate ; and that the *Serum* in the one, as well as in the other, becomes a stiff Gelly by a little standing. And this Variety of Experiments hath taught us, that probably more useful Preparations, and certainly a truer *Analysis* and Separation of the Parts of vegetable Drugs, may be effected, whilst they are in bleeding and liquid, than after they are once become concrete, and have lost their natural Fermentation.

By Dr. Willis,
lis, n. 95.
p. 6060.

De Cerebro,
c. 15. 19.

2. The Veins of Plants, which Mr. *Lister* observes not to be ramified, but rather Bundles of them divaricated, represent the Nerves, which (as Dr. *Willis* observ'd) go together in that which seems the common Trunk, like a Bunch of Threads, which after separate, and are variously divaricated; and these Nerves being cut, shrink up as the Veins of Plants, as much or more, than do the Veins or Arteries of Animals.

Dr. *Willis* observes also, that there are two sorts of Nerves : One arising from the *Cerebrum*, subservient to voluntary Motions, which properly belong to the Functions of Sense ; the other from the *Cerebellum*, subservient to the involuntary Motions, which chiefly belong to the Functions of Vegetation. And to these latter seem reducible those Acts of Sense, which Mr. *Lister* speaks of, in Plants.

The Nature
and Difference of the
Juices of
Plants ; By
Dr. Lister.
n. 224. p. 365.

LXIV. We observe that mostly Juices of Plants coagulate, whether they be such as are drawn from the Wounds of a Plant, or such as do spontaneously exsudate : And yet even that Exsudation seems to be often accidental too, that is, by a Cancer, or some other such like chance.

And yet I am uncertain what to think of the small purple Blebs and Veins to be observ'd, more or less, on all the *Hypericum* Kind, and on the Threads of the Flower, and the Hairs which cover the Leaves of *Rorella* in like manner. I doubt much, whether this may properly be call'd an exsudated and coagulated Juice, or no. Our Observations of those of this Tribe, are what follow.

Purple
Juices.

The small green Leaves, next encompassing the yellow Flowers of *Androsæum Hypericoides* Ger. are set with very small round Blebs, full of a purple Juice ; as are likewise, but with two or three only, the very Points or Tops of the yellowish Leaves themselves : Yet the Stalk cut doth not to the Eye discover any such distinct Vessels, carrying that purple Liquor, which makes me suspect it is separated by Coagulation from the rest of the Juice, and reserved in those small Bags.

Hypericum Ger. The purple Juice yielding Blebs, in this Point are upon the Edging, on the out-sides of all the Leaves. Also the Stalk, tho round, hath a double Edge, on each side one ; and the Blebs or Bags, tho but thinly, are yet observable on these very rising Edges too of the Stalks. As for the yellow Flowers themselves the outmost green Leaves, next and immediately encompassing them, have but a few purple Stripes, but the yellow Leaves or Flowers, are edged with small purple Bags on the one side, and striped with purple Juice yielding Veins on the other. Lastly, On the very Tops of each Thread in the Flower, is one single purple Bag.

Hypericum

Hypericum Ascyron dictum, Caule quadrangulo, J. B. In like manner all the Edges on the outside of all the Leaves, from one end of the Stalk to the other of this Plant, are very thick set with purple Bags. Also in the Flower, all the Threads have one single Bag on the top; but the Flowers or yellow Leaves, and the green ones encompassing them, have very few purple Spots or Streaks visible.

Hypericum pulchrum Tragi, J. B. Only the yellow Flower-Leaves, and those green ones which next encompasses them, are thick edged with purple Blebs.

Diverse parts of the same Plant have diverse Faculties, *V. C. P. A.* I add, that diverse parts of the same Plant, yield from the same Veins different colour'd Juices. *v. g.* the Milk in the Root of *Spondylium Ger.* is of a Brimstone Colour; but in the Stalk white.

Amongst those Juices that coagulate and are clammy, some there are which readily break with the Whey.

In the middle of *July* I drew and gather'd of the Milk of *Lactuca sylvestris spinosa C. B.* which it freely and plentifully affords. It springs out of the Wound thick as Cream and Ropes, and is white; and yet the Milk which came out of the Wounds, made towards the top of the Plant, was plainly streaked or mixt with a purple Juice, as tho one had dash'd or sprinkled Cream with a few drops of Claret. And indeed the Skin of the Plant thereabouts was purplish also, perhaps with Veins. Again in the Shell I drew it; it turn'd still yellower and thicker, and by and by curdled, that is, the white and thick caseous part did separate from a thin purple Whey. So the Blood also of Animals, whilst warm, remains liquid and alike: But so soon as cold it cakes, and has a *Serum*, or Whey, separated from it. Also the caseous part of the Milk of Animals is glutinous and stringy. Further, this *Serum* came freely from the other, by squeezing betwixt my Fingers; and the Curds I wash'd in Spring-water, which became immediately like Cags and tough (draw this Milk immediately, or let it fall off the Plant, into a Shell of fair Water, or other *Menstruum*; as Vinegar, *S. V.* Spirit of Vitriol, or Sulphur, &c.) and remain'd still white and dry. As for the purple Whey, after a Day's Insolation, it stiffned and became hard, and was easily formed into Cakes, which Cakes were yet very brittle, and would easily crumble into Powder. About *December* following I broke one of the Cakes made of the caseous part of the Milk of this Plant; it then prov'd very brittle and shined, upon breaking, like Rosin: It was then of a dark brown Colour: Moreover, it burned with a lasting Flame, like Rosin or Wax; and that being melted by Heat, it would draw out into long tough Strings like Bird-lime. On the contrary, the purplish Powder, which was the Whey, if put into the flame of a Candle, would scarce burn with a flame at all, but soon be turn'd into a Coal. Lastly, The purple Powder did taste very bitter; whereas the caseous part was insipid as Wax.

The Milk which the *Trachelium* kind plentifully yields, is very thick, and presently curdles; the serous part, or Whey, being of a brown Colour. These

Juices smell sour, something like the Slices of green Apples, which have been long cut.

The thin Milk of *Tithymallus Helioscopius* Ger. springs freely and plentifully; it is very clammy upon the Fingers; it is very white in drawing; it turns upon a Lancet, of a dark bluish; and indeed it is both of the Colour and Consistence of blue skim'd Milk; made up with Wheat Flower into Cakes, it shews it self greasy or oily, and scarce ever dries: it very hardly breaks or coagulates. I kept some of it pure and unmixed, in little Essence-Bottles, stop'd lightly with Cork only; in these it broke in process of time, and the Curds were easily to be form'd into Cakes; which Cakes burn'd with a lasting Flame, and being melted drew forth into Strings like Wax; the Whey was clear and like fair Water. This broken Milk in all my Bottles was very corrupt and stinking: But the Cakes I made up of this Juice, with Wheat Flower and a little Gum Arabick, dry'd well, and kept sweet.

Juices ca-
king and
not letting
go their
Whey.

Other clammy Juices there are, which do not let go a Whey when they coagulate, but cake altogether.

I made Cakes of the sole or unmixed Juice of *Sonchus lavis*, & *asper*, without any Addition, and it parted not with any Whey.

Papaver Rheas Ger. bleeds freely a white Juice, and the Heads or Seed-Vessels, when the Flower is gone, do yet bleed. I observed that in gathering it into Shells, it presently turn'd its white Colour into a yellow one inclining to an Orange. At first springing it roaped, or was but little clammy, and seem'd to be very liquid and dilute; yet it did not part with any Whey, but grew stiff soon, and is very resinous and oily.

Note, The Milks or Juices of Plants seem to be compounded, and mixt of Liquors of different and perhaps contrary Qualities; so that it is probable, if the caseous part shall be Narcotick, for example, the Whey may not be so; or the one may be hurtful, and the other a good and useful Medicament.

Trogopogon flore luteo J. B. yields a Juice which, upon the first springing from the Wound, is white and thick, but immediately it turns yellow, and then redder and redder. It is of no unpleasant Taste; it is something glutinous and oily, and parts not with much, if with any Whey, and therefore it is easily formed into Cakes alone.

Convolvulus major J. B. bleeds freely a white Juice, as I experienced in the middle of August; not only the Stalk and Leaves, but the white Flowers also in proportion bleed as plentifully as any part else. This Milk is very sharp.

Saffron-co-
loured
Juice.

There is also a Juice of a Saffron Colour, which *Chelidonium majus* Ger. wounded freely affords. This Juice breaks not with a Whey, but is easily formed into Cakes, and stiffens in the Sun: It is thick, and of the consistence of Cream, upon the springing out of the Wound.

There is another very clammy Juice, which is of a golden or yellow Colour, upon drawing; and this the Seed-Vessels of *Centaurium luteum perfoliatum* C. B. in July, and after, even where the Seeds therein contained are turned black and ripe, yield plentifully and freely enough. (These Juices, which

which the Heads, or Seed-Vessels of Plants afford, may be thought of the same Nature with those Juices which the Pulp of Fruits affords, the Pulps of Fruits and these exterior Vessels being parts equivalent; that is, Apples for example, are nothing else but the Seed-Vessels of their Kernels;) It is liquid upon the first drawing, and after a while it thickens, parting with no Whey; (N. B. I call this coagulating too) and this is of the Colour of Amber; it sticks to one's Fingers, and pulls forth into Threads like Bird-lime; it would never become harder than very soft Wax, and that by being dry'd in the Shade only: for if ever so little be exposed to the heat of the Sun or Fire, it straitway became exceeding soft. But as for the Cakes I made up of it and Wheat-flower, them I found in my Cabinet in Winter very hard and firm, and the unmixt Cakes still soft. These burn with an unpleasant Smell; they emit a lasting Flame; they still keep their Amber Colour, and draw out in Threads, in burning like Wax.

To this we may add the yellow Juice which the Wounds of *Angelica sativa* Park. yield; it will not harden by Insolation, or long keeping (for I have had an Essence-Bottle of it by me these two Years) yet I perceive it stiffens, and will draw into Threads.

The next sort of coagulate or clammy Juices we have taken notice of, are *Gums*. Gums; and some of them seem long to abide liquid, and perhaps inflammable; others there are which grow hard, and are not to be kindled into a Flame. They are easily to be dissolved in Fountain-Water, (the Gum of Rhubarb and the Leaves, for example) and do sparkle when put into a Flame: Which two Natures argue a serous or watrish Part in them. Again, put into a Flame, they melt and become as it were liquid and ductile; which shews the caseous part in them. And because they will not flame, it is an Argument of their Leanness, and Scarcity of Oil. All three put together plainly evince Gums to be coagulate Juices.

In August I have observed the Clusters, both green and ripe, of *Periclymenum* Ger. very leaky; which upon nearer and heedful Inspection I found to be a thin clammy Juice, or liquid Gum, which fell down upon the Leaves, and keeps its liquid Form there.

Here the purple Juice seems to be a Whey separated from the liquid Gum: But I am of opinion it's a distinct Liquor.

Again the red Threads of *Rorella* end, or are topped, with little Bags; which being compressed do yield a purple Juice (as we above noted in the *Hypericum*) and those small Buttons on the very tops of those Threads, are encompassed with small transparent Pearls or Drops of a liquid Gum. They abide in this Form the hottest Summer's Day like Dew, whence also the Plant has its Name; and upon the least Touch cleave to your Fingers, and draw out into long Threads like Bird-lime.

In like manner a liquid Gum (but that it stands not upon so long Threads, and is much thicker bedewed) you may observe upon *Pinguicula*. Note well, That the small Drops and Threads, or Hairs, in either of these

two Plants, are to be seen upon the uppermost or inmost side of the Leaf; and the utmost and undermost is smooth or void of them; which is something contrary to all other Plants I have observed.

Methought I observ'd about the middle of *August*, the Chats of the Alder to be gummy. Perhaps it did exsudate from the Plant it self; as I guess the Honey-Fall, or gummy Dew to be observed upon the Leaves of the Oak, &c. are nothing else.

Hard Gums. The *American*, or *Indian Rhubarb*, sown in our Gardens, is the only Plant that I have met with, or ever saw, which yielded a Gum; and yet because it is of the very kind with our common Sorrels and *Lapatha*, I believe it not impossible, that even from our own Store, Herb-Gums might someways or other be had. I say, that off the Stalk, or indeed off the Leaves of the *Indian Rhubarb*, I have gather'd an Ounce at a time in *June*, of very white, clear, and hard Gum: In both those Years I observed it to flower with us, as 1670, and in that Year it did not, 1669. It exsudates from all parts of the Stalk and Ribs, on (*Note well*) the underside of the Leaf it self. I gathered some in the form of good big Drops, others as tho the Stalk had been besmeared with it, others shot into long and twisted Wires, or Icicles. Moreover I observed, that the canker'd Orifices or Places where the Gum had burst forth, might be followed into the Stalk with a Knife, and that thro the Skin, in certain Places, I could see that the Juice within the Plant was turned gummy, and looked clear like Ice.

Cat. Pl.
Aug. App.
P. 325, 334.

It is the Experiment of Mr. *Fisher*, that the clear and defecated Juices of most Plants have more or less Redness in them. Again, that the dried Root of *Acetosa* (a Plant of the Family with Rhubarb, which may well be called the *Indian Sorrel*, or four Docken) boiled, doth dye Water with a fair red Colour. And I have observed, that the unripe Seeds of Rhubarb yield a very fair and deep Purple, I mean the Husk of them. Consider what hath been said above of *Rorella*, and the *Hypericum* kind, concerning their Purple Juice yielding Blebs. *Note*, also here to this Purpose what we have set down above, that Rhubarb, Sorrel, &c. do when they decay turn red.

The Juice extracted from the Roots of our *English Rhubarb*, by a Tincture of fair Water steam'd away, is nothing else but a lean uninflamable Gum; and tho it differ in Colour (perhaps from the yet woody Parts in it, as being of a deep Liver Colour) from the exsudating Gum, yet in other Natures, as this of being uninflamable, ductile in the Flame of a Candle, &c. it agrees with it. I may not omit, that the repeated Cuts I gave the Stalk, on purpose to have the Gum that way, failed my Expectation. This Gum is sweet, or rather of no Taste at all.

To this purpose I remember in Summer time to have seen, even the Juice of Apples spontaneously gellied in *Languedoc*, and the Apples to look clear and hard like Ice, whence they call that sort of Apple, *Pome Gellee*, or the frozen Apple: Tho indeed, it be nothing else but the breaking or coagulating of the Juice in some Spots of it; for it is rare to see one of them all over so.

We may here give a probable Reason why a gentle Infusion or Maceration of Rhubarb is a very sure Purge, but the Substance or Powder of Rhubarb, or a Decoction thereof, will have a quite contrary Effect, and bind. We may, I say, think that the sharp and tart Juice in Rhubarb, wherein its purging Faculty lies, is by a gentle Infusion so extracted, that it turns not to Gum in our Stomach: for I cannot think that the sour Juice of Rhubarb is a specifically distinct Liquor from the Gum, which I believe to be only an accidental Coagulation.

Green Plums, or Sloes, do often break forth with a Gum, which is clear and transparent; and it seems to hasten, if not ripen, at least the red Colour. I have cut them, to the end that I might have gathered Gum in the Wounds: which indeed I did, but yet long after, when the Wounds seem'd to be cancer'd, and that but in a small quantity to what they voluntarily spend.

Lauro-cerasus, a beautiful Winter-green, which we have adopted to adorn our Court-Walls with, yields a clear Gum very plentifully; it is very white and very clear.

There are other sorts of Juices, which will not of themselves, that I have observed, exsude out of the Wounds of their respective Plants.

I wrenched and wounded the Holly the latter end of *March*, and yet after some Days of warm and open Weather, I could not perceive the least stirring of Juice: The latter end of *May* the Bark begins to be full of Lime, which you may try by pressing a piece of it betwixt your Fingers, and when you would take them off, the Juice or Lime draws out into Hairs, and follows your Fingers, cleaving to them like small Threads.

This Lime or Juice is separated or taken out of the Bark thus; peel off the Bark the Months of *May*, *June*, or *July*; for then it comes easily away, and most abounds with Juice: Boil the Bark in fair Water, until it be so tender, that the utmost thin grey Bark or Membrane, peel easily off; lay it so peel'd, and cover it over with green Nettles or Fern, or such like. *S. S. S.* in a Cellar for about 10 Days, where it will ferment or rot, and become mouldy: Take them out and beat them well in a Mortar to a Paste, and roll them up into small Hand-balls, and in a running Spring wash them clean from all the woody or sticky Parts; which is effected by pulling and teasing them. But *Note well*, that great Care is to be taken in the washing of the Balls; for besides that they must, if possible, be forthwith washed, the Lime will all get from you, except you so order the matter, by engaging it with your Fingers, that it entangle. You would imagine, that upon breaking one of the Balls, that there was little or no Lime in them, so freely they moulder and crumble. After it is once engaged thoroughly, it will endure washing; and the clearer you take away the woody Parts, the better it is.

In cutting the tender Tops of Elder, the latter end of *May*, there will a stringy Juice follow your Knife, and draw out in Threads, somewhat like Bird-lime, or the Juice of Holly: It seems to be in certain Veins just within the Circle of Teeth or Wood.

Further,

oily Juices. Further, the dissected Veins of many Plants afford us Oil, that is, such a Juice, which being rubb'd betwixt ones Fingers, is not at all clammy, but makes them greasy and glib. Some of it stiffens not, as far as I have yet experienced; yet I believe it to be coagulate and mixt.

We will instance in the Juice of *Helenium*, five *Enula Campana*, J. B. You may take it off with a clean Knife, whereon it looks like Oil mixt with Water; that is, the thin or dilute Juice of the Plant, springing up out of the Wound, together with the Oil. The like Experiment may be made upon *Cicuta*. The Juice of *Angelica sativa* Park. I found altered after a Year's keeping, and grown very Limy.

Tapsus barbatus Ger. If you strip off the Leaves in June, it seems to yield an oily Juice, but very much thinned with the watery one. It springs freely enough; it is of a dark green Colour, and I took it in Wheat-flower, and made it up in Cakes.

Also the Fruits of many Plants afford Oil, as *Oliva*, *Bacca Lauri*, *Hedera*, *Juniperi*, *Cornus Fœmina*, &c.

The Pulp of most Seeds seem to abound with this oily Juice, and at some-time before their Maturity it is liquid and visible in them, in the Form of a Milk.

Helleborus niger syl. *adulterinus*, etiam *Hyeme virens*, J. B. The Seeds of this Plant, the latter end of May, are very milky, and by Insolation are easily form'd into Cakes, which are yet very oily; and being long kept, I have exposed to the Flame of a Candle, which they received and burnt freely; sparkling not very much, and not then neither being clammy at all. One thing I must not omit, that this Milk or Juice of the Seeds is of a very fiery and stinging Nature; for where I cut the Seeds out of the green Pods, they struck my Eyes no otherwise than Onion is wont to do. Moreover the tops of my Fingers, which were wetted with this Juice, did boaken and ach, as when after extreme Cold one has the Hot-Ach in them; and that Pain continued in them for several Days: at length the Skin of my Fingers End peel'd off.

Diacodium Album is a Medicament of the Seeds of Poppey.

Rosins.

There are other oily Juices, which after Coagulation harden and are call'd *Rosin*; and such our Ivy yields abundantly. Hither also may be refer'd the Juice of *Juniperus vulgaris*, *baccis parvis purpureis* J. B. which is a hard fat Juice, and not much gummy.

In the Chops of Ivy made in March, there did exsude a thick matter like Barm, yellowish and greasy: It melted like Oil betwixt my Fingers, not having the least clamminess then perceivable. In process of time it hardened and crusted on the Wounds like coarse brown Sugar. It burns with a lasting Flame, and smells very strong.

Also on the topmost Leaves of *Lactuca* syl. *Costa spinosa* C. B. In July many small Drops or Pearls of an oily Juice, like coagulated and hardened Rosin, are plain to be discerned, especially with a single Microscope: They are of an Amber-Colour, and transparent; easily to be wiped off, as being

ing an oily Juice exsudated. And I am of the mind, that even the blue Flower of ripe Plumbs is nothing else but a fine resinous Coagulation of the transudated Juice.

On the under side of the Leaves, and all over the Stalk of *Bonus Henricus* *J. B.* do stick infinite small transparent Pearls: those clear Drops are hard to the Touch, and feel like greasy Sand; not clammy, and therefore it was well called unctuous by *C. B.* and we put this spontaneously exsudated Juice amongst the resinous Coagulations.

The Juices of Plants are also varied and distinguished by Fermentation. And not only the Juices of Fruits are to be wrought, or set a working; as of the Apple, Pear, Briar, Grape, &c. as is well known: But there is an artificial Change, *viz.* Malting, to be made even in the Seeds of Plants, so as to make them spend freely, or let go their Juices, and communicate them to common Water, and receive a Ferment: also the Juice of the Roots of *Glicyrrhiza* will ferment: also the Juice of Cane, as Sugar. Again, the tapped Juices of Vegetables (wherein my Observations are limited) are susceptible of a Ferment. As for instance;

The 21st of *Apr.* 1665. about 8 in the Morning, I bor'd a Hole in the Body of a fair and large Birch, and put in a Cork, with a Quill in the middle: After a Moment or two it began to drop, but yet very softly: Some 3 Hours after I return'd, and it had fill'd a Pint Glass, and then it dropp'd exceeding fast, *viz.* every Pulse a Drop. This Liquor is not unpleasant to the Taste, and not thick or troubled: Yet it looks as tho some few Drops of Milk were spilt in a Basen of Fountain-Water. There are many ways of fermenting or setting this Juice a working, that is, of keeping it from coagulating.

The Maple, both that which is miscall'd the Sycamore, and the lesser, bleed a fermentable Juice copiously, in the breaking up of hard Frosts.

Also the Willow, Walnut, Poplar, Whicking, are all said to bleed in their Seasons a vinous Juice.

To extract the Juice of Vegetables, as *Opium*, for example, (as is usual in the best Preparations and Methods of making *Laudanum*) with Spirit of Wine, is not probably to separate any one part of that coagulate Juice from the other, as the *Serum* or Whey; for example, from the caseous part of the Juice, but only to depurate or defecate the *Opium*; For *S. V.* says *Mr. Boyle*, will dissolve *Gum. Lacc. Benzoin*, and the resinous Parts of *Fallap*, and even of *Guaiacum*, which are Coagulations and mixt Juices; and the same we may think of the Juices that are extracted by *S. V.* from other Herbs that are mixt.

Also, those other ways of roasting and drying Juices upon Plates over a gentle Fire, until they will rub to Powder, gives no great Satisfaction to me, that the *Narcosis* of *Opium*, for example, is gone or separated, because the dry'd Juice less offends the Nose; that is, smells not so strong.

The Whey of *Lact. syl.* will be only dissolv'd in cold Water, the Curds wholly refusing to mix with it: So that simple Water perhaps is the best *Menstruum*, and really separates what *S. V.* only depurates.

LXV. That.

Herbs of the
same Make
and Class,
for the Ge-
nerality,
have the like
Virtue, by
Mr. Ja. Pe-
river, n.
255. p. 289.

LXV. That Plants of the same Figure or Likeness, have for the generality much the same Virtues and Use, will not be thought an improbable Conjecture, if we consider that the Organs and Structure of all Plants of the same Family, or Class, must have much the same Vessels and *Ductus*'s to consummate that regular Formation; and consequently the Juices circulated and strained thro them, cannot be very heterogeneous; and that as for the most part the Scent and Taste have great Affinity, so of course their Virtue likewise cannot be very dissimilar.

1. As for instance, the Tribe of umbelliferous Herbs. It's the property of these Herbs to have the Position of their Flower-branches to proceed from one Basis, or Center, which expand themselves into an Umbel, whose Flowers consist of 5 irregular. or rather unequal, (that is, differing in shape and bigness) pentapetalose Leaves, from whence their Seed are produced, which are naked or double, or by their splitting seem so. This Genus I generally observe to be endowed with a carminative Taste and Smell; they are powerful Expellers of Wind, and are therefore good in all flatulent Diseases, and of great Use in the Cholick, &c. To instance a few, for example, as Anise, Caraway, Cummin, Angelica, Smallage, Parsly, Lovage, &c. The greatest Virtue of these Plants lies in the Seed, and next in the Roots, and in the Leaves of some few.

2. The *Planta Galeata* and *Verticillata* are a Family of Plants which bear their Flowers in Rundels or Whorles, at more or less distances round the Stalk, whose monopetalose Flowers (if we may so call them, being such at the bottom) being tubulose, contrary to the last, are generally divided into 5 unequal Segments, as the Umbels; but with this distinction, that the two greater *Petala*, or Flower-Leaves in this Tribe, are sometimes above, and other times below; whereas the other are constantly the same; that is, always lie in the same Place, being expanded on a flat or plain Surface. The Flowers of our verticillated Plants, from the different Position of their *Petala*, are therefore distinguish'd under the *Flores Galeata*, seu *Labiata*. The *Calyx*, or the Case to the lower or tubulose part of each Flower, serves also for its Seed-Vessel: In the bottom of which is contained, in all I have yet observ'd, 4 Seeds set close together upon a Plain, which Nature lets fall out when ripe, the Husk being always open, and commonly divided into 5 Points, adequating the Segments of each Flower. The Sovereign Balm of these Herbs chiefly consists in the Leaves and Husks, rather than the Flowers. My reason for giving this Preference to the Husks of this Tribe, before the Flowers, contrary to all Authors, are, because I commonly observe [the *Calyces* are the chiefest, if not the only part, on which I find its viscous or sulphureous Particles to adhere; this you may very easily perceive, not only by its much stronger and penetrating Smell, but by the clamminess of this, far beyond the other Parts, as is very apparent; particularly in the Husks of Sage and Clary. And if with Spirit of Wine you make a Distillation of these alone, you will find them much stronger than from a greater quantity of Flowers only; which being of finer and more volatile Parts, are only capable of

of retaining what the Vicinity of the stronger and thicker Texture which the *Calyces* are composed of, and can without prejudice easily communicate to them.

I look upon the generality of this Tribe, to be a Degree warmer than the last; and their Heat consequently to approach nearer to the *Aromata*, or Spices, than the Carminatives; and the Effects thereof to be more peculiarly appropriated to such nervous Diseases as are more intense, and the *Umbellifera* cannot so quickly reach, viz. Apoplexies, Epilepsies, Palsies, &c. in which cases our Lavender, Rosemary, Sage, *Stachas*, and some others, are Simples, which all our antient Physicians in these stubborn Diseases, have very much applauded. And we ought not to forget Mint, Baum, Penny-royal, Savory, Thyme, Hyssop, Marjoram, Basil, Origanum, Dittany of *Crete*, Marum or common Mastick-Thyme, with *Marum Suriacum*, and some other.

3. We proceed next to those Herbs which have a tetrapetalose regular Flower; (by Regular, I mean, such as have 4 equal *Petala* in each Flower.) These, in relation to their Seed-Vessels, are subdivided under two Heads, viz. *Siliquosa*, and *Capsulata*; being such as have their Seeds contained in long or short Receptacles, as Pods or Capsules. The most essential Virtue and Use of the Herbs of this Class, I observe are more particularly in the Leaves and Seed; and next them the Roots, and if any Parts are slighted, they are the Flowers and Pods.

The Leaves are more particularly used in the Water and Garden-Cresses, Sea and Garden Scurvy-grass, Hedge-mustard, *Iberis*, or *Sciatica* Cresses, *Lepidium*, *Piperitis Officinarum*, *Cardamine*, *Bursa Pastoris*, &c. To which may be added, our Cabbage, Coleworts, Savoys, Sprouts, &c. which are of this Tribe also.

Others of this Family that are more peculiarly eminent for the Virtue contained in their Seed, are the common Mustard and Rape, the *Thlapsi Discoridis* or Treacle-mustard, the *Eruca* or Rocket, and *Sophia Chirurgonum*, or Flixweed; the Seed of which last, I am informed, hath some Years past been used by several People in the North of *England*, for the Stone and Gravel, with very good Success.

We come now to the Roots, 2 or 3 of which have gained no small Repute, as well in Diet as Physick, viz. the Radishes both Garden and *Spanish*, (which is the large black-rooted) as also the Wild or Horse-Radish; and to these the round and long rooted Turnep must be added.

Most of this Tribe I find, tho they are very hot like the 2 last, viz. the *Umbellifera* and *Verticillata*, yet they exert their Power in a much different manner, to wit, by a diuretick volatile Salt; and are found most prevalent and effectual in Chronick Diseases: as the Scurvy, Dropsy, Gout, Jaundice and other ill Habits of the Body, where the Blood is vitiated, rather in its Particles than irregular Motion; carrying off its Impurity by a diuretick *Discreasis*, or Discharge of the offending heterogeneous Salts therein contained; and consequently by Purification, disposing of it to a better, or more sane Disposition.

The separated Bark of a Tree reunited to the Tree, by Dr. Ch. Merret, n. 25. p. 453.

LXVI. In the midst of *March, An 1664*. I made a Section of the Rinds of Ash; and of the Tree falsely call'd Sycamore. The first Section of each of the Rinds was square, whereof 3 Sides were cut, the 4th uncut. The Success was, that the whole Bark did unite, by binding it with Packthread, leaving a Scar in each of the sides cut.

Then I cut off, and separated entirely from the Tree, several Parts of the Bark, some shallower, leaving part of the Bark on; others, to the very Wood it self: both in the Trunk and Branches, from an Inch-square to less Dimensions, and some of them I bound close with Packthread, all which were separated, a new Rind succeeding in their Place. Some I covered over, beyond the place of Incision with a *Diachylon* Plaster, and tied them fast with Packthread. All which thus bound and plastered, did, within the Space of 3 Weeks, firmly unite to the Tree; not without some shrivelling of the outward Skin of the Bark, and also with some shrinking in each side, where the Incision was made, where also appear'd in each of the Interstices a Scar. But tying the same about *Michaelmas*, and in the Winter Season, at neither of these times any Union could be made of the Bark to the Tree; I suppose it was because the Sap mounted not so vigorously, and in such Plenty, as in the Spring Season.

Some Branches of the forementioned Trees were decorticated round, and where no Union was, there certainly followed a withering of the Branch beyond the Place, where the Section was made.

I also separated a Twig from the Branch, by cutting of it sloping, for the better fastning of it to the Branch again. This Twig I exactly fitted to the Branch from whence 'twas cut, in the same Posture it before grew in. I firmly bound it, and covered it with *Diachylon* Plaster. The Success was, that in 3 Days time the Twig that was cut off withered.

Observations concerning the Barking of Trees, by S. Malpi, n. 161. p. 645.

LXVII. Nutritii succi Plantarum motum exploraturus, in multiplicibus variisque Arboribus corticem vinculo vel circumfione, avulsa ejusdem annulari portione tentavi; & Plantæ superior portio, ultra scilicet sectionem perpetuo intumuit, debitumque sortita est augmentum, inferior vero nullum adepta incrementum, solas interdum dedit gemmas. Hanc eandem sectionem in humiliori trunci parte, & in radicibus ipsis excitavi, & perpetuo superior trunci vel radicum pars insigniter intumuit, & ab hac radiculæ copiose emanarunt, inferior vero, reliquaque radice portio frequenter gracilescendo, tandem contabuit. Quare confirmare videtur nutritii succi refluus motus ab extremis ramis ad ultimas usque radices; unde intercepto alimento, compressione, vel laceratione vasorum, remotiores Plantæ partes solito non gaudent alimento; tumorque ex relabente succo excitatur: propagatur autem a foliis ipsis usque ad radicum extremos apices. Quapropter florum cultores soluto in gyrum cortice, tenellum ramum a paterno emancipant trunco, circumaffusa madida terra, in qua erumpentes novæ radiculæ supra sectionem vegetare incipiunt: Alimentum enim inferiora versus propulsum, vel expressum, non solum prope corticis sectionem

onem stagnando tumorem excitat, sed foras irruendo in radículas absumitur; unde sui juris factus furculus, paterno tandem dissociatur trunco. Non raro in radicibus prope flumina, quarum portio obtruncata aperto gaudet Aere, ab ultimis libri finibus gemmæ, radicum loco erumpunt, quæ in ramos sursum attolluntur.

LXVIII. 1. *Anno 1671.* A Crab-tree about 4 Inches in Diameter, was hacked round with a Hatcher, so as to cut pretty deep into the Wood; besides the cutting off of the Bark, for about 4 Inches wide. After which it was the same Year observed to increase above the said hacking very considerably, and to shoot in length of Wood about one Foot. The next Year it increased considerably, and shot in length about 9 Inches; but the 3d Year it dy'd to the very Root.

Experiments of the barking of Trees, by Mr. Tho. Brotherton, n. 187. p. 307.

Much the like was observed in another, part of whose Bark was eaten off by a Canker, that the lower part stood without increasing, and by degrees the Wood rotted and mortified; but the upper part increased to the third Year, when it died also.

A Scots Firr of 3 Years growth, having a Ring of the Bark cut off, of the breadth of 3 Inches, near the bottom of the Stem or Stalk, below the uppermost Knot or Joint, was observed to grow and shoot out its Top about half a Yard, and the parts all about the Ring to increase very much in thickness; much more than it would have done, if the Section had not been made. But all that part of the Stock between the said Ring and the Knot next below it, increased not at all: But that part which was below the next Knot, increased somewhat, yet not so much as if the said Ring of the Bark had not been cut off. The 2d Year it also increased considerably, but not so much as the first, but the 3d Year it died.

Fig. 174.

A Branch of the Tree had a Ring cut off from it, *Apr. 1. 1686.* and the Part above the Section increased, and grew till the 17th of *October* following, when it was cut off from the Tree. In this space of time the part below the Ring increased not at all, but stood at a stay; but the parts about the Ring shot out a new Joint between a Foot and half a Yard, and increased in thickness for the whole length of it, and in all its parts, twice as much as it would have done if it had not been cut, as was apparent by a like Branch on the opposite side of the Knot, which was not cut nor barked round in the same manner; the Bark also of the Part above the Section swell'd or grew downwards over the woody Part, which was bare, above half an Inch in breadth.

The usual Time for making this Section was either in *March* or the beginning of *April*.

Trial was made upon some young Trees, cutting a Helical Swath of the Bark, about half an Inch in breadth, by leaving a like Helical Swath of Bark to communicate between the upper and under part. In this Trial the difference of Growth succeeded not, but the remaining Swath

X x x x 2

of

of the Bark swelled downwards, and by the End of the Year, covered the bared Part of the Wood.

The like Event almost followed upon making an indented Section round, of about half an Inch in breadth; the upper Bark quickly swelling downward, and joining again with the lower.

It was also observable, that as the upper Bark grew downwards, so it increased also in thickness, whereas the Bark below the Section thickened not at all.

A *Scots Fir* of 3 Years Growth, which shoots forth every Year both from the Body and the Branches a new Joint and circumambient Sprouts, to a determinate length, was barked with 3 Rings of about $1\frac{1}{2}$ Inch broad, each about the middle of the *Internodia* or Parts of the Stock between the Joints. In a Year, this Stock, which was about the bigness of a Quill, below the Ring to the next Joint, continued of the same bigness, but above the Ring it increased and grew to the bigness of ones Finger; and from the new Joint shot out new Limbs and Stock about a quarter of a Yard, which was somewhat bigger than if there had been no Ring made. The Branches increased likewise proportionably, by swelling in bigness, and from a new Joint shooting out new Body and Limbs, at the Top or Body. And the Body of the Tree below the Joint to the 2d Ring, increased more than if the Ring had not been made: But the part of the Stock below the Ring to the next Joint, increased not at all. The like shooting and increasing was observ'd in the 2d Limbs, Joint and Stock below it, between which and the lowest Joint it increased not.

On one of the lowermost Branches of a young *Scots Fir* of 2 Years old, was made a Ring Section between the Body and first Knot of the Limb. The following Year, that Part of the Limb above the Ring increased twice or thrice as much as the corresponding Parts of the other Limbs from the same Knot, but the part below the Section to the Body increased not at all.

Fig. 175. A young *Hazel* was cut into the Body with a deep Gash, and the Parts of the Body above and below, cleft upwards and downwards, and the Splinters *a.* and *b.* by Wedges, were kept off from touching each other, or the rest of the Body. The following Year the Splinter above the Gash, was grown very much, but the Splinter below stood at a Stay, and grew not, but the rest of the Body grew as if there had been no Gash made.

Four young *Poplar-trees*, all of equal Bigness, Growth, Situation and Soil, as near as could be found, were thus order'd. The first had all its Branches and Top cut off; the second had all its Branches pruned off, but it was left with a small Head at the Top; the third had the Branches cut off half-way, and those of the upper half left growing; the fourth was left growing without being at all prun'd or lopp'd. In the following Years, the first shot out many Twigs round about, but the Body increased but little in height or bigness; the second shot out likewise many Twigs where it had been pruned, and the Top-branches and Top also increased considerably, and the Body also increased much more in height and bigness than did the former; the third increased yet much more in all its Parts, than the second; but the third increased in
Limbs,

Limbs, Height, Bigness, most of all; swelling in Bigness, and stretching in height, and spreading in its Boughs, much more than the third; and in about 10 Years, was more than 4 times as big as the first.

In the great Frost, 1684. of 25 Poplars that had been pruned, 19 were killed by it, and the remaining were very weak, and hardly able to recover, and increased very little in the following Years. These Poplars were about 30 Foot high, and had only a small Head left at the top unlopped, of about 4 or 5 Foot, and were pruned the Spring before the great Frost. Divers also of those which had been pruned two Summers before the Frost, were kill'd by it; but none of those which had not been pruned at all, were hurt by it. And both in *Lancashire* and *Cheshire*, Trees of 60 Foot in height, that had been pruned, and had only a small Top left, were also kill'd by the said Frost, whereas those Trees of the same kind and height, which stood near to 'em, but had not been pruned, continued to flourish, and suffered no Harm thereby. Several of those Branches of about an Inch Diameter, and Trees, that had been barked round, (as above) the Spring before the great Frost, outlived the Violence of the same, and the preceding Winter.

Where these Prunings had been try'd upon Trees 20 Foot high, the Difference of their Increase was sensible the following Summer: but in 7 or 8 Years time the difference is prodigious; the unpruned Trees growing several times bigger than the pruned, both in Body and Branches.

When the Top-Branches would shoot out and grow 2 Foot, or more in length, the lower Branches would not shoot above 4 Inches; and in the Branches of the *Scotch Fir*, the Joints above the Rings barked round, would encrease and grow much bigger in 3 Years, than they would in 5 Years, if the said Rings were not cut off.

A very large Pinaster, about 2 Foot and a half in Diameter, and of a Height proportionable (*viz.* of about 20 Yards, the lowest Boughs of which were about 30 Foot above the Ground) did spread and flourish on every side alike, tho it had no Root at all towards 3 Quarters of its Situation, but only toward one Quarter, into which it spread its Roots very far and large, divers of them reaching about 70 or 80 Foot from the Body of the Tree: The Reason of which spreading, was occasioned by its being planted just within the square Angle of the Corner of a deep, thick and strong Stone-Wall, which was as a kind of Banking or Wharfing against a River that ran by it.

Upon Consideration of these, and divers other Observations and Experiments, I am of opinion, 1. That the Sap (most of it, if not all) ascends in the Vessels of the lignous Part of the Tree, and not in the cortical Part, nor between the cortical and lignous Parts. 2. That the Increase and Growth of a Tree in thickness, is by the Descent of the Sap, and not by the Ascent. And if there were no Descent, a Tree would increase but very little, if at all. 3. That there is a continual Circulation of the Sap, all the Summer Season, and during such time as the Sap is stirring; and not a Descent at *Michaelmas* only, as some have held.

By E. H. ib.
P. 313.

2. To me it seems very probable, that the Bodies of Plants, as well as those of moving Animals, are nourish'd and increased by a double Food; the one an impregnated Water, and the other an impregnated Air, and that without a convenient Supply of these two the Vegetable cannot subsist, at least not increase. These do mutually mix and coalesce, and parts of the Air convert to Water, and parts of Water convert to Air. And as some of this latter are rarified and freed from their Chains, and become spiritual and airy, so others of the forementioned are clogg'd and fetter'd, and become debased. To this purpose all Plants as well as Animals, have a two-fold kind of Roots, one that branches and spreads into the Earth, and another that spreads and shoots into the Air: Both kinds of Roots serve to receive and carry their proper Nourishment to the Body of the Plant, and both serve also to convey and carry off the useless Recrements; useless, I mean, any further within the Body of the Plant, tho useful to it when they are separated, and without it; the one for seasoning the Earth and Water wherein it is planted, and the other for seasoning and preparing the Air.

The Communication of the Parts of the Tree with the Parts of the Fruit; By Dr. J. Beal. n. 48. p. 860. n. 46. p. 919. Vid. Sup. Sect. LX. 6.

LXIX. I had an excellent Summer Apple containing abundance of very pleasing Juice; it was of that kind, which never grows large. The Body by the Burden of the Fruit always wreathed towards the Ground, the Branches were all curl'd, and full of Knots at every turning, and these Branches are apt to grow, if a good Knot be set in the Ground, as soon as 'tis cut off, especially about *Candlemas*. This Tree was hollow, and very near all the Timber extremely rotten, from the top of the Stem to the Root; and every Sprig, how small soever, appear'd Cork-colour'd and rotten at the Heart of the Timber. And so it was generally all over the Roots; and 'tis like it had been so many Years before: yet the Tree bore abundantly, with alternative Rests every second or third Year. The Fruit had scarce any Core; the Kernels were very small, thin, and empty; nevertheless the Branches from the Knots grew well enough to replenish a Nursery for me. This seems to intimate the Correspondence between the pithy Part, Heart or Timber, and the Seeds. And more to confirm this, a young Tree grew like a Sucker from the only sound Root of the aforesaid Apple-Tree. This Tree grew straiter than others of the same kind usually do; of which I conceive the Cause to be this, Suckers are commonly barren a pretty long time; and this continued barren till the Stem was strong enough to bear the Fruit which loaded the Branches. But that which makes to our purpose, is this: All the Fruit of this young Tree had full and sound Kernels; and tho it was the same Fruit, growing from the Root of the same Tree, yet it seem'd not altogether so tender, delicious, and juicy, as the Fruit of the old Tree; nor yet was the Tree so fruitful. The Sap in the old Tree was less diverted, it seems, to sustain the Life of the Timber, which was now consum'd, and thereby was wholly appropriated for the Leaf, Blossom and the Pulp of the Fruit. For I do not undertake, that the Sap yields no Relief to sustain the Life and Growth of the Timber ordinarily, and whilst the Timber is entire: but I rather conceive, that there is a more immediate and peculiar relation between the Sap and pulpos Fruit, and the like between the Timber,

Timber or whole Stock, and the Root of the Tree, to transmit the same Spirit and Nature to the Seed, of what kind soever it be.

Some are of opinion, that there passes into the Timber no part of mere Earth to sustain the Life and Growth of the Plant, but it only feeds on the succulent Part, ascending by the Roots, and on the Air, and the Moisture which the Dews of Heaven, the rainy Seasons, and the Air afford. And if we consider, that some lofty Trees grow upon the Rocks, where little or no Earth can be found; as also, how largely the Oak and Pear-Tree grows and spreads; and how many Years the one bears Acorns, the other Pears; sometimes to the quantity of yielding 5 or 6 Hogsheads yearly (as I have known them do) and in comparison, how little Waste of Earth about the Roots appears; we may find more cause to attribute this large Expence of Materials to the perpetual supply of Moisture, than of much Earth. I will give you an Experiment, which may seem to determine the point, tho I yet suspend my Judgment.

I took the largest *Kentish* Codlins, Pearmains, Pepins, and *Deuxans*; I withered them (which may be soon done many ways) and then I cut them in the middle, quite thro the midst of the Kernels: having carried them some Days in my Pocket, all that saw them took them to be very Wood, and they were indeed like very close Cork: And some philosophical Persons (tho I affirmed no Falshood, but conceal'd the whole Matter) did upon the view, spread it abroad, that I had the Art of converting all Fruit into Wood; Pulp and Kernels and all was Wood. The same may be done upon Pears, Cucumbers, Turnips, and all the Grains and vegetable Seeds, that are stuck in them, and are cherished by a supply of marly Water; thus I have had the Blades of Wheat and the Halme of Pease grow out of them to the length of a Foot: and then, by hanging it in a Closet, all becomes turned into Wood; and in some time after all is turned into Dust and Earth. And as we are well taught by *Mr. Boyle*, that pure Liquids may be converted into Earth; so these terrestrial Parts of the Fruit may be, from the Liquors thither collected, and derived from the Mass of the Earth.

But to return to the clearing of the Affinities above claimed, I instance in Barberry-Roots, perforated by me, which bore Berries that had no Stones at all; and in hollow'd Apple-Trees the Kernels will be very thin, and empty Skins, and incapable of Growth. Gardiners tell me, that if you take the hard Stick out of the Root of Parsly, it will bear no kind of Seed. But it may be objected, that a very hollow Oak and an hollow Elm do bear pregnant Seed. I answer, that an Elm is all Timber to the Bark; and an Oak, when 'tis all putrid at the Heart, yet may have firm Wood enough to convey the Spirit of the Root into the Acorn; and the Roots may be found, when the Body of the Tree is much decayed by Rain beating in at the lop'd Tops, or by other Passages thro the Bark. We see that Beans, Wheat, and other Grains, grow kindly, if the Eye and Parts next adjoining be whole, tho the Beans be full of great Holes in other Parts, or the main Body of the Wheat be cut off with Scissors. However, let the Objection give us the more Caution, that if we design to have Fruit without Stones, the Perforation be the bolder and the more compleat.

And

And to proceed further, some Trees are less fruitful, or altogether barren, by the excessive Growth and Firmness of the Timber: And these are recover'd by cross deep Hackings thro the Bark, and such Injuries done to the Timber, both in the Stem and main Roots; and they cleave the Roots, and put a Stone in the Cleft, that it may not close again too hastily. If this Violence be not done both to the Stem and Roots, the Remedy may fail. We see also, that Vines are less fruitful, when they are permitted to run out into many woody Branches.

To shew also the Proximity between the Sap of the Bark, and the Pulp of the Fruit. I did in the Summer-time make Rests for Water on the Body of the *Kentish* Codlin-Trees, and caused Water to be frequently poured into those Cavities. The Effect was this, the Apples grew to an extraordinary Bigness, and were very insipid; and many of them had parts in appearance much like the Pulp of Lemons. Some I suffered to hang on the Tree as long as they would, and those became full of Spots of the Colour of Cork, or like the Rottenness of an Apple.

I omit the rest, and hasten to redouble a Remark of the great use which may be made of the chiefest Experiment. The Graft carries the Mastery from the Stock for the Pulp of the Fruit; so that we have little hope of much change by meer Graftings, how oft soever reiterated. But if after many, and strange, and choice Engraftings, you set the Kernel, Stone, or Seed of the grafted Fruit in a kind Mould, you may then expect some new or mingled kind of Plant, as Semi-Apricocks, &c. And thus the Almond and Peach may by many changes in the Graftings, and by Inteneration of the Stones of the Peaches, and of the Shells of the Almonds, and by Terebrations of the Stem and Root, here and there, alter their Guises, so that the Coat of the Almond may approach to the Pulp of the Peach; and the Kernel of a Peach be enlarged to a kind of Almond. And great store of better Contrivances may from hence take rise.

Observations concerning Vegetation; By Dr. J. Beal. n. 56. p. 1131.

LXX. It is very difficult to determine whether Salt or Water be the nearer and more original Principle of all mix'd Bodies; or the more copious, more active, or more influencing, in this or that Body. But this we have before our Eyes, that Birch and Alder feed more kindly on a thin uliginous Moisture; the Elm, Pine, Firr, Pitch, and Cypress, chuse a stronger Liquor: Yet these and many more of the widest Difference, are sometimes seen to draw their whole Sustenance, Bulk, and Ornaments, whether annual or perennial, from the Liquors they find in the same Piece of Ground, and from the ambient Air, and Dews; when as yet by our best diligence we cannot distinguish the Liquors or Salts closely approaching their several Roots. And we may change all the Earth totally from the Roots of Trees, whose Barks, Sap, Fruit and Seed have very much differing Salts, and are of very different kinds; and yet see each Tree prosper the better by the exchange. Hence we may suspect, that the very Contextures of their Bodies, from the first spurting of the Seed, and as they are formed gradually from the invisible Principles or Spirit and Vigour of their Seeds, however small and imperceptible, are the natural Alembicks, where the common Rain-Water and Air, are digested

digested into very much differing Leaves, Fruit, Seed, Resins, Gums, cooling Juleps, &c. perhaps as the Cow's Belly converts the common Juice of all sorts of Grass into Milk; or as the Bee ferments the Dew of all Flowers into Honey and Wax.

We see also, that an handful of Moss, sometimes above a Span long, and resembling Vegetables, grows out of a small Oyfter-shell, without Earth, Dirt or Sand, for the relief of the Root; Trees out of bare Rocks, and the annual Attire of Harts and Bucks, out of their bony Heads. Whence we may easily apprehend, how the Seeds in their time, and afterwards the Roots, Stems, and Leaves of Trees, may be the proper Strainers to generate the peculiar Saps and Juices; and perhaps to ferment and boil the Liquors into their several Salts. It may pass for a resemblance, if not for an instance, that the Juice of some sweet Pears may be dried into a very sweet Sugar; and the Juice of some other Pears is so fierce, that at the opening of the Rind with the Teeth, it doth almost suffocate, as if it would kill dead immediately; and yet this Juice by time and seasonable Maturation becomes sweet, winy and luscious. And we hear of divers Exotick Fruits that will kill outright, and that so quick as may challenge the fiercest *Menstruum* of an expert Chymist. Now as the Horns of a Stag have their whole Growth and Virtue from the protruding Blood and Spirits of the Animal, the Moss (as by the Microscope appears when withered) from the inward Shell of the Oyfter and the marine Water: So in Plants, the Sap may by Heaters and Coolers, and other Changes in Summer, Autumn and Winter, by Winds, and compressing Air, be hardened into Timber, Seeds, and their Stones and Kernels. All seems to be but Sap at the first Draught, or little else besides pure Air and Water, till these be concreted into peculiar Salts by more curious Strainers, and by more subtle Boilers than Art hath hitherto devised. And this was my Aim in a former Paper, where by a slight and cursory Allusion, I compared the Motion of Sap in Vegetables to the Descent of Liquors in an Alembick: I had no thought of squaring the comparison to agree in all Circumstances; neither had I any fancy, that the Sap in Winter descended to the Root, since I saw an Apple-Tree, that yielded 4 or 5 Hogsheads of strong Cyder yearly, and a Pear-Tree that yielded more Perry; yet both growing on a dry Ground, where they could get no other Liquor than what the Clouds and the Air afforded. Yet I conceive, that these Trees have an intercourse of peculiar Spirits some way linked together, and vigorously cooperating, from the very Fibres of the lowest Roots to the top-Leaves.

Vid. Sup.
Sect. LX. 1.

LXXI. The Antients generally intituled the Earth to the Production of the Animals, Vegetables and other Bodies upon and about it: But several of the Moderns, and some of very great Name too, both here and abroad, have given their Votes in behaf of Water. My Lord Bacon is of opinion, *That for Nourishment of Vegetables the Water is almost all in all, and that the Earth doth but keep the Plant upright, and save it from Over-heat and Over-cold.* Others there are who are still more exprefs; and assert Water to be the only Principle or Ingredient of all Natural Things. They suppose,

Some Thoughts and Experiments concerning Vegetation; by Dr. J. Woodward, n. 253. p. 193.

pose, that, by I cannot tell what Process of Nature, Water is transmuted into Stones, into Plants, and, in brief, all other substances whatever. *Hellmont* particularly, and his Followers, are very positive in this; and offer some Experiments to render it credible; and Mr. *Boyle* discovers a great Propensity to the same Thoughts and Opinion they had.

The Experiments they insist upon are chiefly two; the first is, that Mint and several other Plants prosper and thrive very greatly in Water. The other is this: They take a certain quantity of Earth, and bake it in an Oven; then they weigh it, and put it into an earthen Pot; having well water'd this Earth, they make choice of some fit Plant, which being first carefully weighed, they set in it. There they let it grow, continuing to water it for some time, till 'tis much advanced in bigness. Then they take it up, and tho the bulk and weight of the Plant be much greater than when first set, yet upon baking the Earth, and weighing it, as at first, they find it little or not at all diminished in Weight; and therefore conclude, 'tis not the Earth, but Water that nourishes, and is turned into the Substance of the Plant.

I must confess, I cannot see how this Experiment can ever be made with the Nicety and Justness that is requisite. However, nothing like what these Gentlemen would infer, can possibly be concluded from it; unless Water, which they so plentifully bestow upon the Plant, in this Experiment, be pure, homogeneous, and not charged with any terrestrial Mixture; for if it be, the Plant after all, may owe its growth and encrease intirely to that.

Some Waters are indeed so very clear and transparent, that one would not easily suspect any terrestrial Matter were latent in them: Yet that is far short of a Proof, that in reality there is none. For they may be highly saturated with such matter, tho the Eye be not presently able to descry or discern it. If pure and absolutely refined Silver be perfectly dissolved in Spirit of Nitre, or *Aquafortis*, that is rectified and thoroughly fine, it does not darken the *Menstruum*, or render it less pellucid than before.

But, after all, I never met with any Water, that however fresh, and newly taken out of the Spring, did not exhibit even to the naked Eye, great numbers of exceeding small terrestrial Particles, disseminated thro all Parts of it. Thicker and crasser Water exhibits them still in greater Plenty.

These are of two general kinds. The one a vegetable terrestrial Matter, consisting of very different Corpuscles, some whereof are proper for the Formation and Increment of one sort of Plant, and some of another; as also some of the Nourishment of one sort of the same Plant, and some another. The other kind of Particles sustain'd in Water, are of a mineral Nature: In some Springs we find common Salt, in others Vitriol, in others Alum, Nitre, Spar, Oker, &c. Nay, frequently several of these, or other Minerals, all in the same Spring. All Water whatever is much charged with the vegetable Matter, this being fine, light, and easily moveable. As for the Mineral, the Water of Springs contains more of it, than that of Rivers, especi-

especially when at distance from their Sources : and that of Rivers, more than the Water that falls in Rain.

If any one (who desires further Satisfaction herein) put Water into a clear Glass Vial, stopping it close, to keep Dust, and other exterior Matter out, and let it stand without stirring it, for some Days, he'll then find a considerable Quantity of terrestrial Matter in the Water, however pure and free it might appear when first put into the Vial. He'll in a very short time observe, as I have frequently done, the Corpuscles, that were at first, while the Water was agitated and kept in motion, separate and hardly visible, by degrees as the Water permits by its becoming more still and at rest, assembling and combining together ; by that means forming somewhat larger and more conspicuous *Molecula*. Afterwards he may behold these joining, and fixing to each other ; by that means forming large thin Masses, appearing like *Nubecula*, or Clouds in the Water, which grow more thick and opaque, by the continual appulse and accretion of fresh Matter : If the said Matter be chiefly of the vegetable Kind, 'twill be sustained in the Water, and discover at length a green Colour, becoming still more of that Colour ; I mean an higher and more saturate green, as the Matter thickens and encreases. But if there be any considerable Quantity of mere mineral Matter in the Water, this being of a greater specifick Gravity than the vegetable, as the Particles of it unite and combine in such Number, till they form a *Molecula*, the *Impetus* of whose Gravity surpasses that of the resistance of the Water, subsides a great deal of it to the bottom. Nor does it only fall down it self, but frequently intangling with the vegetable *Nubecula*, forces them down along with it.

Upon the whole, 'tis palpable and beyond reasonable contest, that Water contains in it a very considerable Quantity of terrestrial Matter.

Now the Question is, to which of these, the Water or the earthy Matter sustained in it, Vegetables owe their growth and increase.

For deciding of which, I conceive the following Experiments may afford some Light : And I can safely say, they were made with due Care and Exactness.

An. 1691. I chose several Glass Vials, that were all, as near possible, of the same shape and bigness. After I had put what Water I thought fit into every one of them, and taken an account of the Weight of it, I strained and tyed over the Orifice of each Vial, a piece of Parchment, having an Hole in the Middle of it, large enough to admit the Stem of the Plant I designed to set in the Vial ; without the confining or straitning it so as to impede its Growth. My Intention in this was to prevent the enclosed Water from evaporating or ascending by any other way than only through the Plant that is to be set therein. Then I made choice of several Sprigs of Mint, and other Plants, that were, as near as I could possibly judge, alike fresh, sound, and lively. Having taken the Weight of each, I placed it in a Vial, ordered as above ; and as the Plant imbibed,

and drew off the Water, I took care to add more of the same from time to time; keeping an account of the Weight of all I added. Each of the Glasses were, for better distinction, and the more easy keeping a Register of all Circumstances, noted with a different Mark or Letter, *A, B, C, &c.* and all set in a row, in the same Window, in such manner that all might partake alike of Air, Light, and Sun. Thus they continued from *July 20th* to *October 5th* which was just 77 Days. Then I took them out, weighed the Water in each Vial, and the Plant likewise, adding to its Weight that of all the Leaves that had fallen off, during the time that it stood thus. And lastly, I computed how much each Plant had gained; and how much Water was spent upon it. The Particulars are as follow:

Distinction of the Glasses.	The several Sorts of Plants and Water.	Weight of the Plant.		Weight gained in 77 Days.	Expense of Water.	The proportion of the Increase of the Plant to the Expense of Water.
		when put in.	when taken out.			
A.	Common Spear-Mint set in Spring-Water.	gr. 27	gr. 42	gr. 15	gr. 2558	1, to 170 $\frac{1}{11}$
B.	Common Spear-Mint, in Rain-Water.	28 $\frac{1}{4}$	45 $\frac{1}{4}$	17 $\frac{1}{4}$	3004	1, to 171 $\frac{1}{11}$
C.	Common Spear-Mint, in Thames-Water.	28	54	26	2493	1, to 95 $\frac{1}{11}$
D.	Common Solanum, or Night-Shade, in Spring-Water.	49	106	57	3708	1, to 65 $\frac{1}{11}$
E.	Lathyrus, seu Cataputia Gerh. in Spring-Water.	98	101 $\frac{1}{2}$	3 $\frac{1}{2}$	2501	1, to 714 $\frac{1}{4}$

The common *Solanum* in the Vial D. had several Buds upon it when first set in the Water: These in some Days became fair Flowers, which were at length succeeded by Berries.

Two other Vials F. and G. were filled, the former with Rain, the other with Spring-Water, at the same time as those above-mentioned were; and stood as long as they did. But they had neither of them any Plant; my Design in these being only to inform my self, whether any Water exhaled out of the Glasses, otherwise than thorow the Bodies of the Plants. The Orifices of these

two Glasses were covered with Parchment, each Piece of it being perforated with an Hole of the same Bigness with those of the Vials above. In this I suspended a bit of Stick about the thickness of the Stem of one of the afore-said Plants, but not reaching down to the Surface of the included Water: I put them in thus, that the Water in those might not have more Scope to evaporate than that in the other Vials. Thus they stood the whole 77 days, in the same Window with the rest; when upon Examination, I found none of the Water in these wasted or gone off; tho I observ'd, both in these, and the rest, especially after hot Weather, small Drops of Water, not unlike Dew, adhering to the Insides of the Glasses, that part of them I mean that was above the Surface of the enclosed Water.

The Water in these 2 Glasses, that had no Plants in them, at the End of the Experiment, exhibited a larger Quantity of terrestrial Matter, than that, in any of those that had the Plants in them, did; the Sediment at the bottom of the Vials was greater, and the *Nubecula* diffused thro the Body of the Water thicker. And of that which was in the others, some of it proceeded from certain small Leaves that had fallen from that part of the Stems of the Plants that was within the Water, wherein they rotted and dissolved.

The terrestrial Matter in the Rain-Water, was finer than that in the Spring-Water.

An. 1692. I repeated the Experiment; the Plants were all Spear-Mint, the most kindly, fresh, sprightly Shoots I could chuse. The Vials were set in a Line in a South Window, where they stood from June 2. to July 28. which was just 56 Days.

Distinction of the Vials.	The several sorts of Waters.	Wt. of Plants when put in.	when taken out.	Weight gain'd in 56 Days.	Expence of Water.	Proportion of the growth of the Plant to the Expence of Water.
H.	Hyde park Conduit Water.	gr. 127	gr. 225	gr. 128	gr. 14190	1, to 110 $\frac{11}{14}$
I.	Hyde-park Conduit Water.	110	249	139	13140	1, to 94 $\frac{27}{13}$
K.	Hyde-park Conduit Water, in which was dissolv'd an Ounce and an half of common Garden Earth.	76	244	168	10731	1, to 63 $\frac{147}{728}$
L.	Hyde-park Water, with the same Quantity of Garden-Mould as in the former.	92	376	284	14950	1, to 52 $\frac{183}{514}$
M.	Hyde-park Water distill'd off with a gentle Still.	114	155	41	8803	1, to 214 $\frac{39}{41}$
N.	Residue of the Water which remained in the Still after that in M. was distill'd off.	81	175	94	4344	1, to 46 $\frac{39}{34}$

The Plant which was set in *H.* was all along a very kindly Plant; and had run up to above 2 Foot in Height. It had shot but one considerable collateral Branch, but had sent forth many and long Roots, from which sprung very numerous, tho small and short lesser Fibres. These lesser Roots came out of the larger, on two opposite Sides, for the most part; so that each Root, with its *Fibrilla*, appeared not unlike a small Feather: to these *Fibrilla* adhered pretty much terrestrial Matter. In the Water, which was at last thick and turbid, was a green Substance, resembling a fine thin Conserve.

The Plant in *I.* was as kindly as the former, but had shot no collateral Branches. Its Roots, the Water, and the green Substance, all much as in the former.

The Plant in *K.* tho it had the Misfortune to be annoyed with many small Insects that happened to fix upon it, yet had shot very considerable collateral Branches; and at least as many Roots, as either that in *H.* or *I.* which had a much greater Quantity of terrestrial Matter adhering to the Extremities of them; the same green Substance here that was in the two preceding.

The Plant in *L.* was far more flourishing than any of the precedent, had several very considerable collateral Branches, and very numerous Roots; to which terrestrial Matter adhered very copiously: the Earth in both these Glasses, *K.* and *L.* was very sensibly and considerably wasted, and less than when first put in; the same sort of green Substance here, as in those above.

The Plant in *M.* was pretty kindly, and had two small collateral Branches, and several Roots, tho not so many as that in *H.* or *I.* but as much terrestrial Matter adhering to them as those had; the Water was pretty thick, having very numerous small terrestrial Particles swimming in it, and some Sediment at the bottom of the Glass. This Glass had none of the green Matter abovementioned in it.

The Water in *N.* was very turbid, and as high coloured (reddish) as ordinary Beer: The Plant in it was very lively, and had sent out 6 collateral Branches, and several Roots.

O. Hyde-park Conduit Water, in which was dissolved a Drachm of Nitre.

The Mint set in this, suddenly began to wither and decay; and died in a few Days. As likewise did two more Sprigs, that were set in it, successively. In another Glass, I dissolved an Ounce of good Garden Mould, and a Dram of Nitre; and in a third, half an Ounce of Wood Ashes, and a Dram of Nitre: but the Plants in these succeeded no better than in the former.

P. Hyde-park Conduit Water. In this I fixed a Glass Tube, about 10 Inches long, the Bore about $\frac{1}{2}$ of an Inch in Diameter, fill'd with very fine and white Sand, which I kept from falling down out of the Tube into the Vial, by tying a thin Piece of Silk, over that End of the Tube that was downwards. Upon immersion of the lower End of it into the Water, this
by

by little and little ascended quite to the upper Orifice of the Tube. And yet in all the 56 Days which it stood thus, a very inconsiderable Quantity of Water had gone off, viz. scarcely 20 Grains, tho the Sand continued moist up to the top till the very last. The Water had imparted a green Tincture to the Sand, quite to the very top of the Tube, and in the Vial it had precipitated a greenish Sediment mix'd with Black; to the bottom and sides of the Tube, as far as 'twas immersed in the Water, adhered pretty much of the green Substance described above.

Q. R. S. &c. Several Plants set in Vials, ordered in like manner as those above, in *Oct.* and the following colder Months; these throve not near so much, nor did the Water ascend in nigh the Quantity it did in the hotter Seasons, in which the before recited Trials were made.

1. In Plants of the same Kind, the less they are in Bulk, the smaller the Quantity of the fluid Mass in which they are set, is drawn off; the *Dissipation* of it, where the Mass is of equal thickness, being pretty nearly proportioned to the Bulk of the Plant. Thus that in the Glass, marked *A.* which weighed only 27 gr. drew off but 2558 Grains of the Fluid: And that in *B.* which weighed only 28½, took up but 3004 gr. whereas that in *H.* which weighed 127 gr. spent 14190 gr. of the liquid Mass.

Some Reflections on the foregoing Experiments. ib. p. 207.

The Water seems to ascend up the Vessels of Plants in much the same manner as up a Filtre: and 'tis no great wonder that a large Filtre should draw off more Water than a lesser; or that a Plant that has more and larger Vessels should take up a greater Share of the Fluid in which 'tis set, than one that has fewer and smaller ones can.

2. The much greatest Part of the fluid Mass that is thus drawn off, and conveyed into Plants, does not settle or abide there; but passes thro the Pores of them, and exhales up into the Atmosphere. That the Water, in these Experiments, ascended only thro the Vessels of the Plants, is certain. The Glasses *F.* and *G.* that had no Plants in them, tho disposed of in like manner as the rest, remain'd, at the end of the Experiment, as at first, and none of the Water was gone off; and that the greatest Part of it flies off from the Plant into the Atmosphere, is as certain. The least Proportion of Water expended was to the Augment of the Plant, as 46. or 50. to 1. And in some the Weight of the Water drawn off, was 100, 200, nay, in one above 700 times as much as the Plant had received of Addition.

This so continual an Emission and Detachment of Water, in so great Plenty from the Parts of Plants, affords us a manifest Reason why Countries that abound with Trees and the larger Vegetables especially, should be very obnoxious to Damps, great Humidity in the Air, and more frequent Rains, than others that are more open and free. The great Moisture in the Air was a mighty Inconvenience and Annoyance to those who first settled in *America*; which at that time was much overgrown with Woods and Groves: But as these were burnt and destroyed, to make way for Habitation and Culture

Culture of the Earth, the Air mended, and cleared up apace, changing into a Temper much more dry and serene than before.

Nor does this Humidity go off pure and alone, but usually bears forth with it many Parts of the same Nature, with those whereof the Plant, thro which it passes, consists. The crasser indeed are not so easily born up into the Atmosphere, but are usually deposited on the surface of the Flowers, Leaves, and other parts of the Plants: Hence comes our Manna's, our Honies, and other gummous Exsudations of Vegetables. But the finer and lighter Parts are with greater Ease sent up into the Atmosphere: thence they are conveyed to our Organs of Smell, by the Air we draw in Respiration; and are pleasant or offensive, beneficent or injurious to us, according to the Nature of the Plants from whence they arise. And since these owe their Rise to the Water that ascends out of the Earth, thro the Bodies of Plants, we cannot be far to seek for the Cause why they are more numerous in the Air; and we find a greater Quantity of Odours exhaling from Vegetables, in warm, humid Seasons, than in any others whatever.

3. A great Part of the terrestrial Matter, that is mix'd with the Water, ascends up into the *Plants* as well as the Water. There was much more terrestrial Matter at the End of the Experiment, in the Water of the Glasses *F.* and *G.* that had no Plants in them, than in those that had Plants. The Garden-mould dissolved in the Glasses, *K.* and *L.* was considerably diminished and carried off. Nay, the terrestrial and vegetable Matter was born up in the Tubes filled with Sand, Cotton, &c. in that Quantity as to be evident even to sense.

If I may be permitted to look abroad a while, towards our Shores and Parts within the Verge of the Sea, these will present us with a large Scene of Plants, that along with the Vegetables, take up into them mere mineral Matter also, in a great abundance. Such are our Sea-purslains, the several sorts of Alga's, of Samphires and other marine Plants. These contain common Sea-Salt, which is all one with the Fossile, in such Plenty, as not only to be plainly distinguish'd on the Palate, but may be drawn forth of them in considerable Quantity.

How apt, and how much disposed this vegetable Matter, being so very fine and light, is to attend Water in all its Motions, and follow it into each of its Recesses, is manifest, not only from the Instances above alledged, but many others. Percolate it with all the Care imaginable, filter it with ever so many Filtrations, yet some terrestrial Matter will remain; 'tis true, the Fluid will be thinner every time than other, and more disengaged of the said Matter: but never wholly free and clear.

I have filtred Water thro several Sheets of thick Paper, and after that, thro very close fine Cloth, 12 times doubled; nay, I have done this over and over, and yet a considerable Quantity of this Matter discover'd it self in the Water after all. 'Tis true, filtering and distilling of Water intercepts, and makes it quit some of the earthy Matter it was before impregnated withal; but then that which continues with the Water after this, is fine and

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light, and such consequently, as is in a peculiar manner fit for the growth, and nourishment of Vegetables. And this is the case of Rain-water; the quantity of terrestrial Matter it bears up into the *Atmosphere* is not great: But that which it does bear up, is mainly of that light kind of vegetable Matter, and that too perfectly dissolved, and reduced to single Corpuscles, all fit to enter the Tubules and Vessels of Plants. On which account 'tis, that this Water is so very fertile and prolific. But the mineral Matter is, a great deal of it, not only gross and ponderous, but scabrous and inflexible, and so not disposed to enter the Pores of the Root. And a great many of the simple vegetable Particles by degrees unite and form, some of them, small Clods or *Molecula*; such as those mentioned in *H, K* and *L*, sticking to the extremities of the Roots of those Plants; others of them intangle in a looser manner, and form the *Nubecula*, and green Bodies so commonly observed in stagnant Water. These also when thus conjoined, are too big to enter the Pores, or ascend up the Vessels of Plants, which singly they might have done; they who are conversant in Agriculture, will easily subscribe to this. They are well aware, that be their Earth never so rich, so good, and so fit for the Production of Corn, or other Vegetables, little will come of it, unless the Parts be separated and loose. 'Tis on this account they bestow the Pains they do in Culture of it, in digging, plowing, harrowing, and breaking of the clodded Lumps of Earth. 'Tis the same way that Sea-Salt, Nitre, and other Salts, promote Vegetation, they loosen the Earth, and separate the concreted Parts of it, by that means fitting and disposing them to be assumed by the Water: and carried up into the Seed or Plant, for its Formation and Augment. There's no Man but must observe, how apt all sorts of Salts are to be wrought upon by Moisture; how easily they liquate and run with it: and when these are drawn off, and have deserted the Lumps, wherewith they are incorporated, those must moulder immediately, and fall asunder of course. The hardest Stone we meet with, if it happen, as frequently it does, to have any sort of Salt intermixt with the Sand of which it consists, upon being exposed to humid Air, in a short time dissolves and crumbles all to pieces, and much more will clodded Earth or Clay, which is not of near so compact and solid a Constitution as Stone is. The same way likewise is Lime serviceable in this Affair: It is well known how apt it is to be put into Ferment and Commotion by Water, nor can such Commotion ever happen, when Lime is mixt with Earth, however hard and clodded that may be, without opening and loosening of it.

4. *The Plant is more or less nourished and augmented in proportion as the Water, in which it stands, contains a smaller or greater quantity of proper terrestrial Matter in it.* The Truth of this Proposition, is so eminently discernable through the whole Process of these Trials, that I think no doubt can be made of it. The Mint in the Glass *C* was much of the same Bulk and Weight with those in *A* and *B*. But the Water, in

which that was, being River-water, which was apparently stor'd more copiously with terrestrial Matter than the Spring or Rain-water, wherein they stood, were, it had thriven to almost double the Bulk that either of them had; and with a less Expence of Water too. So likewise the Mint in *L.* in whose Water was dissolved a small Quantity of good Garden Mould, tho it had the Disadvantage to be less when first set, than either of the Mints in *H.* or *I.* whose Water was the very same with this in *L.* but had none of that Earth mixed with it; yet in a short time, the Plant not only overtook but much outstripped those, and at the End of the Experiment, was very considerably bigger and heavier than either of them. In like manner, the Mint in *N.* tho less at the beginning than that in *M.* being set in that thick, turbid, feculent Water, that remained behind, after that wherein *M.* was placed, was still'd off, had, in fine, more than doubled its original Weight and Bulk, and received above twice the additional Encrease than that in *M.* which stood in the thinner distill'd Water had done; and, which is not less considerable, had not drawn off half the Quantity of Water that that had.

Why in the beginning of this Article, I limit the Proportion of the Augment of the Plant to the quantity of proper terrestrial Matter in the Water, is, because all, even the vegetable Matter, to say nothing of the mineral, is not proper for the Nourishment of every Plant. There may be, and doubtless are, some parts in different Species of Plants, that may be much alike, and so owe their Supply to the same common Matter: But 'tis plain, all cannot. And there are other parts so differing, that 'tis no ways credible they should be formed all out of the same sort of Corpuscles. So far from it, that there want not good Indications, as we shall see by and by, that every kind of Vegetable requires a peculiar and specifick Matter for its Formation and Nourishment. Yea, each Part of the same Vegetable does so, and there are very many and different Ingredients go to the Composition of the same individual Plant. If therefore the Soil, wherein any Vegetable or Seed is planted, contains all, or most of these Ingredients, and those in due Quantity, 'twill grow and thrive there, otherwise 'twill not. If there be not as many sorts of Corpuscles as are requisite for the Constitution of the main and more essential parts of the Plant, 'twill not prosper at all. If there be these, and not in a sufficient Plenty, 'twill starve, and never arrive to its natural Stature; or if there be any the less necessary and essential Corpuscles wanting, there will be some failure in the Plant, 'twill be defective in Taste, in Smell, in Colour, or some other way.

But tho a tract of Land may happen not to contain Matter proper for the Constitution of some one peculiar kind of Plant, yet it may for several others; and those much differing among themselves. The Vegetative Particles are commixt and blended in the Earth, with all the Diversity and Variety, as well as all the Uncertainty conceivable.

It is not possible to imagine how one, uniform, homogeneous Matter, having its Principles or original parts all of the same Substance, Constituti-

on, Magnitude, Figure and Gravity, should ever constitute Bodies so egregiously unlike in all those respects, as Vegetables of different Kinds are; nay, even as the different Parts of the same Vegetable. That one should carry a resinous, another a milky, a third a yellow, a fourth a red Juice in its Veins; one afford a fragrant, another an offensive Smell; one be sweet to the Taste, another bitter, acid, acerb, austere, &c. that one should be nourishing, another poisonous, one purging, another astringent: in brief, that there should be that vast Difference in them, in their several Constitutions, Makes, Properties and Effects, and yet all arise from the very same sort of Matter, would be very strange.

The *Cataputia* in the Glass *E.* received but very little Increase; only $3\frac{1}{2}$ gr. all the while it stood, tho 2501 gr. of Water were spent upon it. I will not say the Reason was, because the Water did not contain in it Matter fit and proper for the nourishment of that peculiar and remarkable Plant. No, it may be the Water was not a proper *Medium* for it to grow in; and we know there are very many Plants that will not thrive in it. Too much of that Liquor in some Plants may probably hurry the terrestrial Matter thro their Vessels too fast for them to arrest and lay hold of it. Be that as it will, 'tis most certain there are peculiar Soils that suit peculiar Plants: In *England*, Cherries are observed to succeed best in *Kent*; Apples in *Herefordshire*; Saffron in *Cambridgeshire*; Woad in two or three of our midland Counties; and Teazles in *Somersetshire*. This is an Observation that hath held in all parts of the World. But that Soil that is once proper and fit for the Production of some one sort of Vegetables, does not ever continue to be so. No, in tract of time, it loses that Property: but sooner in some Lands, and later in others. If Wheat, for example, be sown upon a Tract of Land, that is proper for that Grain, the first Crop will succeed very well, and perhaps the second, and the third, as long as the Ground is in Heart, as the Farmers speak: But in a few Years, 'twill produce no more, if sowed with that Corn. Some other Grain indeed it may, as Barley; and after this has been sown so often, that the Land can bring forth no more of the same, it may afterwards yield good Oats; and perhaps Pease after them. At length 'twill become barren, the vegetative Matter that at first it abounded withal, being educed forth of it, by those successive Crops, and most of it born off; each sort of Grain taking forth that peculiar Matter that is proper for its own Nourishment.

After all which, that very Tract of Land may be brought to produce another Series of the same Vegetables; but never till it is supply'd with a new Fund of Matter, of like sort with that it at first contained. This Supply is made several Ways: By the Ground's lying fallow some time, till the Rain has poured down a fresh Stock upon it; or by the Tiller's Care in manuring it.

And for further Evidence that this Supply is, in reality, of like sort, we need only reflect a while upon those Manures that are found, by constant Experience, best to promote Vegetation, and the Fruitfulness of the Earth.

Earth; these are chiefly either Parts of Vegetables or Animals; which indeed either derive their own Nourishment immediately from vegetable Bodies, or from other Animals that do so. In particular, the Blood, Urine and Excrements of Animals, Shavings of Horns and of Hoofs, Hair, Wool, Feathers, calcined Shells, Lees of Wine, and of Beer; Ashes of all sorts of vegetable Bodies, Leaves, Straw, Roots, and Stubble, turned into the Earth by Plowing, or otherwise to rot and dissolve there; these, I say, are our best Manures, and being vegetable Substances, when refunded back again into the Earth, serve for the Formation of other like Bodies.

We meet with still further Confirmations of the same things in our Gardens. The Trees, Shrubs and Herbs, cultivated in these, after they have continued in one Station, till they have derived thence the greater Parts of the Matter fit for their Augment, will decay and degenerate, unless either fresh Earth, or some fit Manure be applied unto them. 'Tis true, they may maintain themselves there for some time, by sending forth Roots, further and further to a great Extent all round, to fetch in more remote Provision: But at last all will fail, and they must either have a fresh Supply brought to them, or they themselves be removed and transplanted to some Place better furnished with matter for their Subsistence. And accordingly Gardiners observe, that Plants that have stood a great while in a Place have longer Roots than usual; part of which they cut off when they transplant them to a fresh Soil, as now not of any further Use to them.

All these Instances, to pass over a great many others that might be alleged, point forth a particular terrestrial Matter, and not Water only for the Subject to which Plants owe their Increase. Were it Water only, there would be no need of Manures, or of transplanting them from Place to Place. The Rain falls in all Places alike, in this Field and in that indifferently; in one side of an Orchard, or Garden, as well as another; Nor could there be any Reason, why a Tract of Land should yield Wheat one Year, and not the next, since the Rain showers down alike in each.

5. *Vegetables are not formed of Water, but of a certain peculiar terrestrial Matter.* The Plant in *E* drew up into it 2501 gr. of the Fluid Mass; and yet had received but 3 gr. and an half of Encrease from all that. The Mint in *L* tho it had at first the disadvantage to be much less than that in *I*, yet being set in Water, wherewith Earth was plentifully mixed, and that in *I* only in Water without any such additional Earth, it had vastly outgrown the other, weighing at least 145 gr. more than that did, and so having gained above twice as much as that had. In like manner, that in *K*, tho it was a great deal less when put in than that in *I*, and also was impaired and offended by Insects, yet being planted in Water wherein the Earth was dissolv'd, whereas the Water in which *I* stood had none, it not only overtook, but considerably surpassed the other; weighing at least 29 gr. more than that in *I*, and yet had not expended so much Water as that, by above 2400 gr. The Plant in *N*, tho at first a great deal less than that in *M*, yet being set in the foul crass Water, that was left in the Still, after that in which

M was set was drawn off, in conclusion had gained in Weight above double what that in the finer and thinner Water had. The Proportion of the Augment of that Plant that throve most, was to the fluid Mass spent upon it but as 1 to 46, in others it was as 1 to 60, 100, 200: nay in the *Cataputia* 't was but as 1 to 714. The Mint in *B* took up 39 gr. of Water a Day, one Day with another, which was much more than the whole Weight of the Plant originally, and yet with all this it gained not one fourth of a Grain a Day in Weight. Those that in *H* took up 253 gr. a Day of the Fluid, which was near twice as much as its original Weight, it weighing when first set in the Water but 127 gr. and after all, the daily Increase of the Plant was no more than $2\frac{1}{2}$ Grains.

6. Spring and Rain-Water contain pretty near an equal Charge of Vegetable Matter: River-Water more than either of them. The Plants in the Glasses *A*, *B* and *C*, were at first of much the same Size and Weight. At the end of the Experiment, the Mint in *A* had gained 15 gr. out of 2558 gr. of Spring-Water; that in *B* $17\frac{1}{2}$ gr. out of 3004 gr. of Rain-Water, but that in *C* had got 26 gr. out of only 2493 gr. of River-water. So that these Proportions will hold for the Main: Yet I make no doubt, but the Water that falls in Rain at sometimes, contains a greater Share of terrestrial Matter, than that which falls at others. A more powerful and intense Heat must needs hurry up a larger Quantity of that Matter along with the humid Vapours that form Rain, than one more feeble and remiss ever possibly can. The Water in one Spring may flow forth, with an higher Charge of this Matter, than that of another: this depending partly upon the quickness of the Ebullition of the Water, and partly upon the quantity of that Matter, latent in the *Strata*, thro which the Fluid passes, and the greater or less Laxity of those *Strata*. For the same Reason, the Water of one River may abound with it more than that of another. Nay, the same River, when much agitated and in commotion, must bear up more of it, than when it moves with less Rapidity and Violence. That there is a great Quantity of this Matter in Rivers, and that it contributes vastly to the ordinary Fertility of the Earth, we have an illustrious Instance in the *Nile*, the *Ganges*, and other Rivers, that yearly overflow the neighbouring Plains. Their Banks shew the fairest and largest Crops of any in the whole World: They are even loaded with the Multitude of their Production, and those who have not seen them, will hardly be induced to believe the mighty Returns those Tracts made, in comparison of others that have not the Benefit of like Inundations.

7. Water serves only for a Vehicle to the terrestrial Matter, which forms Vegetables, and does not it self make any Addition unto them. Where the proper terrestrial Matter is wanting, the Plant is not augmented tho never so much Water ascend into it. The *Cataputia* in *E* took up more Water than the Mint in *C*, and yet had grown but very little, having received only $3\frac{1}{2}$ gr. of additional Weight, whereas the other had received no less than 26 gr. The Mint in *I* was planted in the same sort of Water as that in *K*
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was; only the latter had Earth dissolved in the Water, and yet that drew off 13140 gr. of the Water, gaining it self no more than 139 gr. in Weight; whereas the other took up but 10731 gr. of Water, and was augmented 168 gr. in Weight. Consequently, that spent 2409 gr. more of the Water, than this in *K.* did; and yet was not so much increased in Weight as this by 29 gr. The Mint in *M.* stood in the very same Kind of Water as that in *N.* did: But the Water in *M.* having much less terrestrial Matter in it, than that in *N.* had, the Plant bore up 8803 gr. of it, gaining it self only 41 gr. the while; Whereas that in *N.* drew off no more than 4344 gr. and yet was augmented 94 gr. so that it spent 4459 gr. of Water more than that did: And yet was not it self so much increased in Weight as that was, by 53 gr. This is both a very fair and a very conclusive Instance.

'Tis evident therefore, that Water is not the Matter that composes Vegetable Bodies; but 'tis the Agent that conveys that matter to them, that introduces, and distributes it to the several Parts for their Nourishment. That therefore there is that plentiful Provision and vast Abundance of it, supplied to all the Parts of the Earth, is a Mark of a natural Providence, superintending over the Globe we inhabit.

This Fluid is capacitated for the Office here assigned it several Ways: By the Figure of its Parts; which, as appears from many Experiments, is exactly and mathematically spherical; the Surfaces being perfectly polite, and without any of the least Inequalities. It is evident, Corpuscles of such a Figure are easily susceptible of Motion, yea, far above any others whatever, and consequently the most capable of moving and conveying other Matter, that is not so active and voluble. Then the Intervals of Bodies of that Figure are, with respect to their Bulk, of all others the largest; and so the most fitted to receive and entertain foreign Matter in them. Besides, as far as the Trials hitherto made inform us, the constituent Corpuscles of Water are each, singly considered, absolutely solid, and do not yield to the greatest external Force. This secures their Figure against any Alteration, and the Intervals of the Corpuscles must be always alike. By the latter it will be ever disposed to receive Matter into it; and by the former, when once received, to bear it on along with it. Water is further capacitated to be a Vehicle to this matter by the tenuity and fineness of the Corpuscles of which it consists. We hardly know any Fluid in all Nature, except Fire, whose constituent Parts are so exceeding subtile and small as those of Water are. They'll pass Pores and Interstices, that neither Air, nor any other Fluid will. This enables them to enter the finest Tubes and Vessels of Plants, and to introduce the terrestrial Matter conveying it to all Parts of them; whilst each, by means of Organs it is endowed with for the purpose, intercepts and assumes into it self such Particles as are suitable to its own Nature, letting the rest pass on thro the common Ducts. Nay, we have, almost every where, mechanical Instances of much the same Tenor. 'Tis obvious to every one, how easily and suddenly Humidity, or the Corpuscles of Water sustained

in the Air, pervade and insinuate themselves into Cords, however tightly twisted, into Leather, Parchment, vegetable Bodies, Wood, and the like. This it is that fits them for Hygrometers, and to measure and determine the different Quantities of Moisture in the Air, in different Places and Seasons. How freely Water passes and carries with it terrestrial Matter, thro Filtrés, Colatures, Distillations, &c. hath been intimated already.

8. Water is not capable of performing this Office to Plants, unless assisted by a due Quantity of Heat : And this must concur, or Vegetation will not succeed. The Plants that were set in the Glasses, *Q. R. S. &c.* in *October*, and the following colder Months, had not near the Quantity of Water sent up into them, or so great an additional Encrease by much, as those that were set in *June, July*, and the hotter. That the Concourse of Heat in this Work is really necessary, appears, not only from the Experiments before us, but from all Nature ; from our Fields and Forests, our Gardens and our Orchards. We see in *Autumn*, as the Sun's Power grows gradually less and less, so its Effects on Plants are remitted, and their Vegetation slackens by little and little. Its Failure is first discernable in Trees. These are raised highest above the Earth, and require a more intense Heat to elevate the Water, charged with their Nourishment, to the Tops and Extremités of them ; so that for want of fresh Support and Nutriment, they shed their Leaves, unless secured by a very firm and hardy Constitution indeed, as our Ever-greens are. Next the Shrubs part with theirs, and then the Herbs and lower Tribes : The Heat being at length not sufficient to supply even these, tho so near the Earth, the Fund of their Nourishment. As the Heat returns the succeeding Spring, they all recruit again, and are furnished with fresh Supplies and Verdure. But first, those which are lowest and nearest the Earth, Herbs, and they that require a lesser Degree of Heat to raise the Water with its earthy Charge into them, then the Shrubs and higher Vegetables, in their Turns, and lastly the Trees. As the Heat increases, it grows too powerful, and hurries the matter with too great Rapidity thro the finer and more tender Plants. These therefore go off and decay, and others that are more hardy and vigorous, and require a greater Share of Heat, succeed in their Order.

The same is observable in distant Climates ; the hotter Countries yield ordinarily the largest and tallest Trees, and those too, in much greater Variety than the colder ever do ; even those Plants that are common to both, attain to a much greater Bulk in the *Southern* than in the *Northern Climes* ; nay, there are some Regions so bleak and chill, that they raise no Vegetables at all, to any considerable Size. This we learn from *Greenland*, from *Iceland*, and other Places of like cold Site and Condition. In these, no Tree ever appears, and the very Shrubs they afford are few, little, and low : Again, in the warmer Climates, and such as do furnish forth Trees, and the larger Vegetables, if there happen a Remission and Diminution of the usual Heat, their Productions will be impeded and diminished in proportion. Our late colder Summers have given us Proof enough of this. For tho
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the Heat we have had was sufficient, to raise the vegetative Matter in the lower Plants ; into our Corn, our Wheat, Barley, Pease and the like ; and we have had plenty of Strawberries, Raspberries, Currants, Goosberries, and the Fruits of such other Vegetables, as are low and near the Earth ; yea, and a moderate Store of Cherries, Mulberries, Plumbs, Filberts, and some other that grow at a somewhat greater height : Yet our Apples, our Pears, Walnuts, and the Production of the taller Trees, have been fewer, and those not so kindly, so thoroughly ripen'd, and brought to that Perfection, they were in the former more benign and warm Seasons. Nay, even the lower Fruits and Grains have had some share in the common Calamity ; and fallen short, both in number and goodness, of what the hotter and kinder Seasons were wont to shew us. As to our Grapes, Apricocks, Peaches, Nectarins, and Figs, being transplanted hither out of hotter Climes, 'tis the less wonder we have of late had so general a failure of them.

Nor is it the Sun, or the ordinary Emission of the subterranean Heat, only, that promotes Vegetation, but any other indifferently, according to its Power and Degree. This we are taught by our Stoves, hot Beds, and the like. All Heat is of like kind ; and wherever is the same Cause, there will be constantly the same Effect.

There's a Procedure in every Part of Nature, that is perfectly regular and geometrical, if we can but find it out ; and the further our Searches carry us, the more we shall have occasion to admire this, and the better 'twill compensate our Industry.

Ground fertilized by Frost ; By Dr. Beal. n. 56. p. 1140.

LXXII. I do often ask Gardiners, and skilful Husbandmen, whether all sorts of Land are more fertiliz'd, or more speedily, by the solar Influence in our Climate, or by Frosts ; and they generally answer, that Frost and Snow make the quicker Dispatch amongst us, and the more general and richer Fertility.

Ground improved by Brine ; By Dr. Jackson. n. 54. p. 1079.

LXXIII. All the Ground (at *Nantwyck*) where Salt or Brine is spilt, is, when dug up, excellent Muck for Grazing-Ground ; and even the Bricks that are thoroughly tinged with it, are very good Muck, and will dissolve with other Muck, and fertilize Land considerably (especially Grazing-Ground) for at least 4 Years.

Improvements with Salt ; By Dr. J. Beal. n. 56. p. 1135.

LXXIV. In the *West of England*, some Husbandmen make use of brackish Sand, and do find a good Reward when they be at the Charges of carrying it far, for the enriching of their Inheritances : whilst other Rusticks will not be intreated to accept of the Brine they have in the midst of their own Grounds. Certainly the saline Steams are carried by the Air and Wind much farther from Salt it self in Heaps or Vessels, than from the Sea-water ; from whence the Dews which arise in Vapours do descend as sweet and pure as the Dew, which ascends from the Earth ; and the Rain shews no difference. And I give you once an experimental Proof, that either the saline Steams, which ascend from a Heap of Salt, do pierce thro very thick

thick Stone Wall: Or, which I did much rather conceive, they generate more Salt, to a great depth of Thickness, in the Lime and Mortar of the Walls.

LXXV. The Sea-sand made use of in the Agriculture of Cornwall, is commonly at or near the Sea-shore; which to distinguish from what is useless, know that the wash of the Sea rolls and tumbles Stones, Shells, &c. one over another; whose grating makes this Sand. If the Matter be shelly, (as we call it) that is, the grating of Stones, it is of small value: But if it be notably shelly, then it is what we desire. And of this shelly Sand are three Colours in our County; about *Plymouth*, and the Southern Coast, the Sand is bluish, or grey like Ashes, which I conceive to be from the breaking of Muscles chiefly and Oyster-shells mixed with it. Westward, near the *Land's-End*, the Sand is very white, and in *Scilly* glistening: This I think comes from the mouldring of Moor-stones, or a kind of Free-stone mingled with very white Shells, such as are call'd (when the Fish are preserved) Scallops. On the North Sea about *Padstow*, and Eastwards to *Lundy*, the Sand is rich, and of a brown-reddish-yellowish Colour, and is mostly of the broken Shells of Cockles, which I guess to be of that Colour there, from the Wash of *Severn*, which falls very dirty into the *Severn* Sea; and perhaps that Accretion of the Shells may be tinged thereby. This we know, that tho there be little or no Sea-Fish near the Mouth of the *Severn*, because of the muddiness thereof, (and therefore Fish is carried to be sold as far as from *Loo* on the South Sea to *Barnstable* on the North) yet lower down in the North Sea, tho there be not so much, yet that which is there is fatter and better than that which is taken in the South Sea.

Now besides these Colours of Sands, there is also a difference in the bigness of the Grain, even in the same Harbour of *Plymouth*; in some Caves 'tis very small, in others greater grain'd. 'Tis said, that the small is best for the Tenant, who only takes to tillage for 4 Years, because it works sooner, and yields its speedy return; the larger grain'd (they say) is better for the Landlord and the Land, because it abides longer in the Ground, and makes the Pasture afterwards the better.

In *Falmouth* Haven, near *St. Maw's* Castle, there is a sort of Sand, or rather Coralline, that lies a Foot under the *Ouze*; which *Ouze* being removed, and the Bed opened, this Sand is taken up by a Dredge, and is used about *Truroe*, *Probus*, &c.

West of the Mount in *Portcuthnoe* Cave is a large shelly Sand: In *White-Sand-Bay*, and about *St. Ives*, it is very white and small.

About *Minver*, *Perinsand*, and *Lelant*, the Sands are blown up by the Wind, and drown abundance of good Land, some Houses, yea, and some Churches and Chappels are even buried with it; nor has any Art been hitherto thought of, to prevent its Devastation.

Now of all these Sands, the best are accounted, as to colour, first the reddish, next the blue, then the white; as to kinds, the most shelly, and the

Improve-
ments in
Cornwall,
with Sea-
sand, by
Dr. Ban.
Cox. n. 113.
P. 293.

Vid. Cap.
III. Sec. LX.

coralline are best, and that which is taken up from under the Salt-water, either by Dredges, or being left open by the ebbing of the Tide; the blown Sand is accounted of no use, and generally, if Sand be well drain'd of the Salt-water, so that it may be more conveniently carried, 'tis better than that which has lain long drying in the Sun and Wind, which takes off much of its Virtue.

These useful Sands are carried by Lighters as far up into the Country, as the Tides will serve to that purpose, and there they are cast on shore, from whence they are fetch'd in some Places by Wheels, but in most (by reason of the hilliness, narrowness and badness of the Ways) on Horseback; one Horse carrying about 13 or 14 Gallons. Seven or eight of these Horses tail'd together, are call'd a Train, which one Man drives to 9 or 10 Miles from the Sand-place; where each Seime, or Horse-load with the Carriage, comes to about 8 *d.* or 9 *d.* in some Places, tho not so much in others: For where it is dredged out of the Sea, it costs 12 *s.* or 13 *s.* the Lighter, containing sixscore Seime, at the Landing-key, or Sand-place; but where 'tis loaded from the dry Beach after the Ebb, it is not above 4 *s.* the Lighter, and all this Charge of Lighterage is besides the Land-Carriage. This Land-Carriage I have computed to amount, in the whole County, to about 32000 *l. per An.*

When this Sand is brought home, it is spread on the Ground intended for Wheat; or usually in the first Crop of four, whatever be the Grain; for after 4 Crops, 'tis our custom to leave our Land to Pasture for 6 or 7 Years before we till it again. And indeed the Grass will be so good immediately after Tillage, that we commonly mow it the first Year. This is call'd Mowing of *Gratten*.

The *Cornish* Acre is 160 Yards of 18 Foot to the Yard; in one of which Acres good Husbands bestow, according to the nearness or distance, near the Sand 300 Sacks (that is Horse-seime or Burden;) where Men go three Turn a Day, about 200; where two Turn, 150; and where but one Turn, 80, or 100. And so proportionably in greater distance, even to 20 or 30 Sacks on an Acre, rather than none.

The Effect is usually where much Sand is used, the Seed is much, and the Straw little. I have seen in such a Place good Barley, where the Ear has been even equal in length with the Straw it grew on: But where less Sand is used, there is much Straw, and but little, and that hungry Grain.

After the Corn is off, the Grass becomes mostly a white Clover, with some purple, if the Land be deeper. And this Grass of well-sanded Ground, tho it be but short, yet as to Feeding, giving good Creams, plenty of Milk, and all other good Purposes, it far exceeds the longer Grass, where less Sand is used. Yea, Garden-Herbs and Fruit in those Places are more, and those better in their kind. In those well sanded Places also little or no Snow lies; there is a continual Winter-spring, an early Harvest (a Month or six Weeks before what is within 6 or 7 Miles of the Place;) yea, such a vast difference

difference of the Air is found in so little a distance, that a Man may in an Afternoon travel, as it were, out of *Spain* into the *Orchades*.

We have in this Country almost all kinds of Soils, and Sand agrees very well with each of them.

There is the same sort of shelly Sand in most of the Coasts of *England*, which lies wholly neglected. In the *Thames* about *Erith*, is taken up a sort of Sand, not much unlike *Plymouth* Sand, made use of only by Brick-makers: But one of them told me, that by the sides of his Sand-heap the Grass did better spring than elsewhere, and turned to a Clover-Grass.

'Tis well known that *Sandwich* Carrots and Pease are well esteemed, and they grow there, where the Sea-sand has a little over-blown and mixed with the Soil.

LXXVI. There are some Towns in the *North-Riding* of *Yorkshire*, standing upon a light sandy Soil, viz. *Tollethorp*, *Tollerton*, &c. which do all of them manure much of their Ground by Clay. This Clay is dug hard by, in the Declivity of a Hill. After having bared away two Yards deep of Sand, they sink a square Pit 6 Yards deep, and 8 or 10 Yards square. The Clay is of a bluish brown Colour, not sandy at all, but close and fat, and very ponderous; it burns well for Bricks. They lay 100 Load of Clay upon an Acre of Ground; they dig it at *Midsummer*, and only in a dry Summer. They observe, that for 3 or 4 Years it continues yet in Clods upon the Land, and that the first Year the Land so manured, bears rank, ill coloured, and broad-grained Barley, but afterwards a plump round Corn like Wheat. This Clay manuring, will by certain Experience last 42 Years in the Ground, and that of *Tollethorp*, 48 Years: And then the Ground must be clayed again.

A sandy Soil manured with clay, by Dr. Lister. n. 225. p. 413.

This sandy Ground, unless clayed, will bear nothing but Rye, whatever other Manure or Lime your Compost be; but once clayed, it will bear Oats, Barley, Pease, &c.

LXXVII. The greatest Improvement of our Husbandry in *Suffolk*, hath been by marling: for 50 Load of Marle to an Acre of dry, barren, liny Heath, make (as they say) a very great Improvement both for Corn, Turneps, Clover-Grass, Nonsuch, and Cole-seed. Of the 3 first, I suppose, I need to say nothing: but of the two last, (which are late Experiments) I have received a very good Account from some *Norfolk* Gentlemen; one of whom, the last Year, had of 7 Acres of Nonsuch, or Hop-Clover, 70 Combs of Seed, besides a great Crop of good Hay, which was twice as much worth as the best Crop of Wheat in this Country. 'Tis sown (as the common Clover) with Corn, and when it once takes, it will hold 4 times as long in the Ground. About a Bushel and an half soweth an Acre, and the Seed is now brought to 12 s. the Comb, (for 4 Bushels) which was lately at 40 s. The same Gentleman had the last Year 10 Combs per Acre of Cole-seed upon a very dry Heath, only improved by Marling.

Improve-ments by Marling, by Mr. Thomas Wright. n. 37. p. 725.

Improving
and drain-
ing the Bogs
and Loughs
in Ireland,
by Mr. W.
King. n.
170. p. 948.

Origin of
Bogs.

LXXVIII. There are few Places in our Northern World, but have been famous for Bogs as well as *Ireland*; every barbarous ill-inhabited Country has them. I take the *Loca Palustria*, or *Paludes*, whither the antient *Gauls*, *Germans* and *Britons*, retired when beaten, to be the very same we call Bogs: And one shall find those Places in *Italy* that were barbarous, such as *Liguria*, were infested with them; and therefore I believe the true Cause of Bogs is want of Industry. There are many Bogs of late standing in *Ireland*; when *O Donald* and *Tirone* came to the Relief of *King'sale*, they wasted the Country, especially as they came thro *Connaught*, which by the means of the Earl of *Clanrickard* was generally loyal; and there is a great Tract of Ground, now a Bog, that was then plow'd Land; and there remains the Mansion-House of my Lord ——— in the midst of it.

But to shew how want of Industry causes Bogs, it must be remember'd, that the Springs (with which *Ireland* abounds) are generally dry, or near dry in the Summer-time, and the Grass and Weeds grow thick about the Places where they burst out: In the Winter they swell, and run, and soften, and loosen all the Earth about them. Now that Scurf or Scurf of the Earth that consists of the Roots of Grass, being lifted up and made fuzzy by the Water in the Winter, (as I have at the Head of some Springs seen it lift up a Foot or two) is dry'd in the Spring, and doth not fall together, but wither in a Tuft, and new Grass springs through it, which the next Winter is again lift up; and so the Spring is more and more stoppt, and the Scurf grows thicker and thicker, till at first it make that which we call a Quaking-Bog: and as it grows higher and dryer, and the Grass-Roots and other Vegetables become more putrid, together with the Mud and Slime of the Water, it acquires a Blackness, and grows into that which we call a Turf-Bog. I believe when the Vegetables rot, the saline Particles are generally wash'd away with the Water, as being apt to be diluted in it; but the oily or sulphureal are those that chiefly remain, and swim on the Water: and this is that which gives Turf its Inflammability.

To make this appear, 'tis to be observed,

1. That in *Ireland* our highest Mountains are covered with Bogs, as well as the Plains, because our Mountains abound more with Springs than can be imagined.

Now nobody living on our Mountains, and no care being taken to clear the Springs, the whole Mountains are over-run with Bogs.

2. It is to be observed, that *Ireland* doth abound in Moss, more than I believe any other Kingdom.

Now this Moss is of divers kinds, and that which grows in Bogs is remarkable; your light spongy Turf is nothing but a Congeries of the Threads of this Moss, as I have frequently observed, before it be sufficiently rotten, and then the Turf looks white and is light: I have seen it in such Quantities,

ties, and so tough that the Turf-Spades could not cut it ; in the North of *Ireland* they call it *Old-wives Tow*, being not much unlike Flax. The Turf-holes in time grow up with it again ; and all the little Gutters and Bogs are generally fill'd with it : And truly I chiefly impute the red or Turf-Bog to it ; and from it even the hardened Turf, when broken, is stringy, tho there plainly appear in it Parts of other Vegetables. And I am almost (from some Observations) tempted to believe, that the Seed of this Bog-moss, when it falls on dry and parched Ground, begets the Heath. However the Moss is so fuzzy and quick-growing a Vegetable, that it mightily stops the Springs ; and contributes to thicken the Scurf, especially in red Bogs, where only I remember to have observed it.

3. It is to be observed, that the bottom of Bogs is generally a kind of white Clay, or rather sandy Marle ; a little Water makes it exceeding soft, and when it is dry, it is all Dust, so that the Roots of the Grass do not stick fast in it : but a little Wet loosens them, and the Water easily gets in between the Surface of the Earth and them, and lifts up the Surface, as a Dropsy doth the Skin.

4. 'Tis to be observed, that Bogs are generally higher than the Land about them, and highest in the middle ; the chief Springs that cause them being commonly about the middle, from whence they dilate themselves by degrees. If you cut a deep Trench thro a Bog, you will find the original Spring, and vast quantities of Water will run away, and the Bog subside : the Bog at *Castle-Forbes* (as I was informed) subsided 30 Foot. I could hardly believe that ; but found by Computation, that it could not be much less than half of it.

I must confess there are Quaking-Bogs caused otherwise ; when a Stream or Spring runs thro a Flat, if the Passage be not tended, it fills with Weeds in Summer ; Trees fall a-cross it and dam it up ; then in Winter the Water stagnates farther and farther every Year, till the whole Flat is cover'd. Then there grows up a coarse kind of Grass, peculiar to these Bogs ; this Grass grows in Tufts, and their Roots consolidate together, and yearly grow higher, insomuch that I have seen of them to the height of a Man.

This Grass rots in Winter, and falls on the Tufts and the Seed with it, which springs up next Year ; and so still makes an Addition. Sometimes the tops of Flags and Grass are interwoven on the Surface of the Water, and this becomes by degrees thicker, till it lie like a Cover on the Water ; then Herbs take root in it, and by a *Plexus* of the Roots it becomes very strong, so as to bear a Man. I have gone on Bogs, that would rise before and behind, and sink where I stood to a considerable depth, under which was clear Water.

The Inconveniences of these Bogs are very great.

1. A considerable part of the Kingdom is render'd uselefs by them ; they keep People at a distance from one another, and consequently hinder them in their Affairs, and weaken them ; for it is certain, that if we suppose a thousand Men live on 4 contiguous Acres, they can both better assist and defend one another, than if they liv'd on 4 not contiguous.

Inconveniences of Bogs.

2. The

2. The Land which generally should be our Meadows, and finest evenest Plains, are covered with Bogs. This I observ'd thro all *Connaught*, but more especially in *Longford*, and likewise in *West Meath*, and in the North of *Ireland*.

3. The Bogs are a great Destruction to Cattle, the chief Commodity of *Ireland*. In the Spring-time, when the Cattle are weak and hungry, the Edges of the Bogs have commonly Grass; and the Cattle venturing in to get it, fall into Pits or Sloughs, and are either drowned, or (if they are found) spoilt in the pulling out.

4. They are a Shelter and Refuge to Tories and Thieves, who can hardly live without them.

5. The Fogs and Vapours that rise from them are commonly putrid, stinking, and very unwholesom. For the Rain that falls on them will not sink into them, there being hardly any Substance of its Softness, more impenetrable by Water than Turf; and therefore Rain-Water stands on them, and in their Pits; it corrupts there, and is all exhaled by the Sun, very little of it running away, which must of necessity affect the Air.

6. They corrupt our Water, both as to its Colour and Taste: for the Colour of the Water that stands in the Pits, or lies on the Surface of the Bog, is tinged by the reddish black Colour of the Turf; and when a Shower comes that makes these Pits to overflow, the Water that runs over tinctures all it meets, and gives both its Colour and Stink to a great many of our Rivers.

Advantages.

1. The Natives nevertheless had heretofore some Advantage by the Woods, and Bogs. By them they were preserved from the Conquest of the *English*, and I believe it is a little Remembrance of this that makes them still build near Bogs. It was an Advantage then to them to have their Country unpassable, and the fewer Strangers came near them, they lived the easier, for they had no Inns; every House where you came was your Inn, and you said no more, but put off your Brogues, and set down by the Fire.

2. They are also now of some use to us; for most of *Ireland* have their Firing from them: Turf is accounted a tolerable sweet Fire; and we having very impolitically destroyed our Wood, and not as yet found Stone-Coal, save in few Places, we could hardly live without some Bogs. I have seen Turf charred; and then it serves to work Iron, and as I have been informed, will serve to make it in a Bloomery or Iron-work. Turf charred I reckon the sweetest and wholesomest Fire that can be, fitter for a Chamber and consumptive People, than either Wood, Stone-Coal or Charcoal.

3. A Turf-Bog preserves things strangely; a Corps will lie intire in one for several Years. I have seen a piece of Leather pretty fresh, dug out of a Turf-Bog, that had never in the memory of Man been dug before. Butter has been found, that had lain above 20 Years: And tho not fit to be eaten, yet it served well enough to greaze Wool.

Trees are found intire in them, and those Birch or Alder, that are very subject to rot. The Trees are supposed by the ignorant Vulgar to have lain there

there ever since the Flood ; but the Truth is, they fell on the Surface of the Earth, and the Bog, as I shewed above, swelling by degrees, at last covered them ; and being of an oily vegetable Substance, it, like a Balsam, preserves them. These Trees burn very well, and serve for Torches in the Night. I have seen of the Trees half sunk into the Bogs, and not quite covered.

All the Inconveniencies of our Bogs may be remedy'd, and they may be made useful to us by draining ; for I never observed one Bog without a Fall sufficient to drain it, nor do I believe there is any. But the great and weighty Objection against this Improvement is the Charge ; an Acre of good Land in most parts of *Ireland*, is about 4 *s. per Annum*, and the Purchase 14 or 15 Years, and therefore 3 *l.* will purchase an Acre of good Land, and it is very doubtful with most, whether that Sum will reduce a Bog. This reasoning passes current, and is the great Obstacle and Impediment of this Work ; but if these things following were done, and considered, I verily believe it would be remov'd.

*The Incon-
veniencies
remedy'd by
draining.*

1. An A& of Parliament should be made, that who did not in such a time make some Progress in draining their Bogs, should part with them to others that would, and allow a Passage to them thro their Lands.

2. 'Tis to be considered, that in Quaking-Bogs one Trench drains many Acres : And when dry, it is generally Meadow, or the best grazing Ground.

3. Every red Bog has about it a deep, marshy, sloughy Ground, which they call the Bounds of the Bog. One deep Trench round the Bog keeps out the Cattle, and turns the Bounds into good Meadow.

4. I remember a red Bog, of 60 Acres, which a Gentleman reduced to good grazing Ground, worth 3 *s.* an Acre, for 25 *l.* which is less than three Years Purchase.

5. Gentlemen ought to consider, that what they lay out this way, goeth by degrees, and they are not sensible of it ; it goeth among the Tenants, and enables them to pay their Rent the better : 'tis a Work of Charity, and employs Hands ; and conduces to both the Ornament and general Profit of the Kingdom.

6. To make the red Bogs fit for grazing, these Rules may be observed.

1. A deep Trench must be made round the Bog. This not only reduces the Bounds of the Bog, as before, but goes a great way to dry the Bog it self. It serves likewise as a common Sink, into which all your Drains vent themselves.

2. Observe which way the little Sloughs run in the Bog, and be sure to cut your Drains a-crofs them.

3. The first Drains on the Bog ought not to be above 2 or 3 Foot deep or wide ; for the Bog is so soft, that deep Trenches will not stand, but fill up again. When the Surface of the Bog is cut in little Trenches, suppose

at

at 20, 30, 40 Perch distance, it will be so dry'd, that Cattle may graze on it all Summer.

4. A Year or two after the little Trenches are made, and the Bog a little dry, they are to be made 6 Foot wide, and as deep as the Softness of the Bog will permit. And this will certainly make the Bog useful for grazing. A Year or two after this you may attempt to cut one or two of the Trenches to the bottom of the Bog; for till that be done, I do not reckon the Bog secured.

5. A Gentleman ought to oblige all his Tenants to cut their Turf in these Trenches, and likewise cut his own so.

6. Where a Bog is pitted, he is to cut a Passage from one Pit to the next for the Water, and so make a Communication to the common Drain; and if his Pits be once dry'd, there will grow Grass or Heath at the bottom, fit for grazing, and they will be a Shelter for Cattle in Storms.

7. When his Bog is dry'd, it is thereby made better Turf; and then he is to set out a part of it for that use, and to oblige them to cut it clear away: And the Bog being removed, the bottom will make a good Meadow.

8. He may cut off the Surface of the Bog, and burn it; or else bring Earth, and lay on it. Sanding, or rather gravelling, is a great Improvement in this Country; the Land so manured will bring Corn 12 or 14 Years. They say gravelling is bad for Grass; but the contrary is apparent, especially in Bogs. I have observed by the Way-side, where the Ways pass thro Bogs, if a little Earth hath fallen on the Bog, as sometimes there doth fall a little of that which they bring to mend the High-way, it has turned the Bog into a green Sod, with a very fine Scotch Grass on it: And I doubt not but the same Charge, that sands or gravels Land, would reduce a dry'd Bog even to be arable.

Improve-
ments of
Loughs.

The natural Improvements of Loughs, or Lakes, is first to drain them as low as we can; and then turn the residue of the Water into Fish-Ponds: By planting a few Trees about them, and ordering them thus, they may be made both useful and ornamental.

And Tur-
loughs.

As to those Places we call *Turloughs*, *quasi Terreni Lacus*, or Land-Lakes, they answer the Name very well, being Lakes one part of the Year of considerable depth, and very smooth Fields the rest. There are in these Lakes

Vid. Sup.
Cap. II. Sect.
XIX.

Holes out of which the Water riseth in Winter, and goeth away towards Summer; many hundred Acres being drowned by them, and those the most pleasant and profitable Land in the Country. The Soil is commonly a Marle, which by its stiffness hinders the Water from turning it into a Bog; and immediately when the Water is gone, it hardens so that you ride thro an even grassy Field. These, if they could be drained, would be fit for any use, would make Meadow, or bear any Grain, but especially Rape, which is very profitable. They are chiefly in *Connaught*; and their Cause is obvious enough: It is a stony hilly Country, and the Hills have Cavities in them through which the Water passes; it is common to have

a Rivulet sink on one side of a Hill, and rise a Mile or half a Mile from the Place. The Brooks are generally dry in Summer; the Water that should be in them sinking between the Rocks, and running under Ground; inso-much as that in some places where they are overflow'd in Winter, they are forced in Summer to send their Cattle many Miles for Water. There is one Place on a Hill near *Tuam* between two of these Turloughs, where there is a Hole the superstitious People call the *Devil's Mill*, and make Fables concerning it: If you stand by this Place, you will hear a great Noise like that of Water under a Bridge. When there is a Flood in Winter, one of the Turloughs overflows, and vents it self into the Hole: And the Noise doth, in all likelihood, proceed from a subterraneous Stream; which in Summer has room enough to vent all its Water, but in Winter, when Rains fall, the Passages between the Rocks cannot vent the Water, and therefore it regurgitates, and covers the Flats.

These Turloughs are hard to drain; often they are encircled with Hills, and then 'tis not to be expected; often they have a Vent by which they send out a considerable Stream, and then it is only making that Passage as low as the bottom of the Flat, and that will prevent the Overflowing; it sometimes happens that the Flats are as low as the neighbouring Rivulets, and in all probability are filled by them, and then it is not only necessary to make the Passage from the Flat to the Rivulet, but likewise to sink the Rivulet, which is very troublesome, commonly the Passage to be cut being rocky: And therefore a good Computation (upon a Survey) ought to be made, whether it be worth the while to attempt it. However the Holes ought to be opened that the Water in its ordinary Course may get sooner away; And they are to be eaten very bare towards the end of Summer, that as little Grass as is possible may be spoilt by the Water.

LXXIX. 1. Jun. 7. 1697. near *Charleville*, in the County of *Limerick* in *Ireland*, a great Rumbling or faint Noise was heard in the Earth, much like unto the sound of Thunder near spent; for a little Space the Air was somewhat troubled with little whisking Winds, seeming to meet contrary ways; and soon after that, in the Bog of *Kapanibane*, upon the Estate of *Brook Bridges Esq*; stretching North and South, the Earth began to move, viz. Meadow and Pasture-Land that lay on the side of the Bog, and separated by an extraordinary large Ditch, and other Land on the further side adjoining to it: and a Rising or little Hill in the middle of the Bog hereupon sunk flat.

This Motion began about 7 of the Clock in the Evening, fluctuating in its Motion like Waves, the Pasture-Land rising very high, so that it overrun the Ground beneath it, and moved upon its Surface, rowling on with great pushing Violence, till it had covered the Meadow, and is held to remain upon it 16 Feet deep.

In the Motion of this Earth, it drew after it the Body of the Bog, part of it lying on the place where the Pasture-Land, that moved out of the place

it had before, flood ; leaving great Branches behind it, and Spewings of Water, that cast up noisome Vapours.

By Mr. J.
Honohane,
ib.

Fig. 176.

2. The Line *A. B.* is the Meridian ; *C.* a Meadow, containing 3 *English* Acres, and 32 Perches ; *D.* first Pasture-Land (but of a coarse boggy Substance) containing 4 Acres 3 Rods. The Line 1, 2, was a Hedge of large Ash and Willow-Trees, between the Meadow and the firm Land ; 3, 4, was the edge of the Bog next to the Pasture. The prick'd Lines from 3 to 5 and from 4 to 6 shew the limits or bounds of the Bog. The Meadow *C.* was lower by a descent of 5 Foot, than the Pasture *D.* and the Pasture *D.* was lower by 6 Foot than the Surface of the Bog. And there was yet a considerable Rising and Hill, as at *E.* the height whereof was more than 10 Foot above the Surface of the Bog, so that there was a descent from *E.* to the Meadow.

The cause of the Motion I presume was this ; a more than ordinary wet Spring occasioned a prodigious swelling of the height of the Bog at *E.* and at length moistened the whole, but chiefly the under-part thereof, the Water soaking to the bottom. By this means the turfy Hill *E.* being as it were undermined, naturally sunk down, and consequently pressed the Bog on all hands, chiefly towards the Descent, till the Pasture *D.* was forced on the Meadow *C.* overturning the intermediate Hedge ; so that the Line 3, 4, is now become 1, 2, and the Meadow and the whole Bog are level, only there are Chasms and great Cracks throughout the whole Surface of the Bog, represented by the Strokes about *E.* The Bog contains 40 Acres.

The Spanish
Sembrador
and its
Uses ; By
the E. of
Sandwich, n.
60. p. 1056.

LXXX. In the Description of this *Sembrador*, (publish'd by *Don Joseph de Lucatello*, Knight, Inventor of the Engine, and dedicated to Signior *Don Geronymo de Camargo*, Counsellor of the *Consejo Real de Castilla* and of the *Hazienda Real*) it is represented ;

1. That both the ancient and modern Husbandmen have agreed, that the Perfection of *Agriculture* consisted in setting the Plants in proportionable Spaces, and giving sufficient Depth to the Roots, that they may spread enough, to receive that Nourishment from the Ground which is necessary to produce and ripen the Fruit.

2. That Care hath not been had, in the practice of this important part of Husbandry ; since even at this Day, all sorts of Seeds, of Corn and Grain, are sown by Handfuls ; throwing them out by Aim, heedlessly and by chance (counting it too tedious and chargeable to set them one by one in large Fields.) Whence we see Corn sowed in some places too thick, in others too thin, and the greater part of it not covered, nor deep enough ; whereby it is not only exposed to be eaten by Birds, but also in cold Countries liable to several Inconveniences. *D. Joseph de Lucatello* hath after much experience perfected an Instrument, which being fastned to the Plough, at once ploughs, soweth, and harrows ; whereby is saved the Labour of the Seeds-Man ; and the Grain falling in order, and in the bottom of the Furrow, all of it remains in one and the same distance under

der Ground, so that of 5 parts of Seed, 4 parts are saved; and then in the Crop is gained incredible Abundance.

3. That the Inventor presented at the Feet of his Catholick Majesty, who caused Trial to be made thereof in the *Buen Retiro*, where it did answer Expectation, notwithstanding the Drought of the Year, then much damnyfying all Corn; an ordinary Husband-Man from a measured space of Ground there, sowed in the common manner, reaping 5125 Pecks, where he by his Contrivance from an equal space of Ground there also, reaped 8175, besides the Seed saved in the Sowing.

4. That thereupon his said Catholick Majesty did grant to the Inventor the Privilege, that he only and his Assigns may make and distribute these Instruments, in all the Kingdoms and Provinces of that Monarchy in *Europe*, at the price of 24 Rials Plate each, and out of *Europe* 32 Rials Plate, of which the 5th part should be paid to the King: Prohibiting to all others the making and using this Instrument under several Penalties.

5. That before the Inventor came to the Court of *Spain*, he made a great Trial of it before his Imperial Majesty, in the Fields of *Luxemburg* in *Austria*, where the Land usually yields four or five Fold: But the Crop from the Ground sowed with this Instrument was sixty Fold; as appears by a Certificate given in *Vienna Aug. 1. 1663. ft. n.* by an Officer of the Emperor appointed to see the said Ground sowed and reaped.

6. That this Privilege being dispatch'd, he publish'd his Contrivance and Instructions as follows.

1. Fig. 177. Is a Box of Wood; *a. b. c. d.* the cover of that part where the Corn is put in; which is open in Fig. 178. at *W.* And *e. f. h. g. k. l.* Fig. 177, the two sides which cover that part of the Box, where the Cylinder, which 178. is struck round with 3 Rows of little Spoons, is moved about to throw out the Corn, (which sides are taken off in Fig. 178. to make the Cylinder *R. S.* with the Spoons *x. x. x.* appear.) The inner shape of these sides is expressed in Fig. 179. where may be seen four triangular pieces *p. p. p. p.* leaving triangular Interstices *q. q. q.* which serve to convey the Corn Fig. 179. carried up in the Spoons, and discharged at the top of the Cylinder, so as they may just run out at the Holes underneath the Box; (the Parts of which answer to the Parts of Fig. 177. according to the Letters.) *T* is one of the Wheels; *V.* the other end of the Cylinder, upon which, the other Wheel is to be placed.

2. This Sembrador must be tied fast to the Plough, in the manner as is seen in Fig. 180. so that the Corn may fall in the Furrow, and at the turning out of the Plough, the Ears of the Plough may cover the Corn of the last Furrow with Earth. Fig. 180.

B b b b 2

3. Because

3. Because the Seed sow'd by this Instrument is placed in a convenient Depth, *viz.* in the bottom of the Furrow, whereas the Seed scattered the common way remains nearer the Superficies of the Earth, or quite uncovered, therefore it must needs shoot forth somewhat later: So that it is requisite, the Husband-man using this Instrument should sow 8 or 10 Days sooner than the accustomed Seed-time; *viz.* beginning to sow in the middle of September, and making an end at the middle of November.

4. In stiff Ground the Furrows ought to be 5 or 6 Inches deep; in middle sort of Ground, 6 or 7; and in light and sandy Ground 7 or 8 Inches: and according to this Proportion the Husbandman must govern himself, deepning or shallowing the Plough, as the Condition of the Land shall require.

5. Special Care must be had that the Wheels on the sides of the Instrument do always turn round, and never drag along without turning; as also that the Ears of the Plough be made somewhat bigger than the ordinary ones.

6. 'Tis also convenient that the Seed be well-sifted and clean'd, that so the little Spoons may every time take up a Grain, and the Seed be the better distributed.

7. In Barley 'tis to be well observed, that it be made clean in that manner, that the Straw and Beards be broken off, as near the Grain as may be; that so they hinder not the issuing of the Grain out of the Instrument.

8. After Seed-time done, Furrows must be made to drain the Land of Water, according to the use of each Country, without doing any thing more extraordinary, till the Harvest.

The following Instructions were also published.

1. Before they sow the Ground, they must give it so many *Tilts* as is accustomed in that Country where the Land lieth.

2. When they go about to sow, the Ploughman must begin to open a Furrow with the Plough for one or two Paces, and when the Plough is in the Ground in a convenient Depth, then they must tie the *Sembrador* to the Plough-Beam, so that the Nails in the Wheels may stand upon the Ground to make the Wheels turn round.

3. The Ears of the Plough are to be made larger than hitherto; whence two Advantages will arise: 1. It will better cover the Furrows when sown, and make wider Furrows to receive the Seed when they do sow. 2. Those larger Ears will prevent the Blows, the great Clods and Stones will give the *Sembrador* (if the Clods be not broken, and the Stones pick'd out.) But when there are such great Stones in the Land, as the Plough cannot penetrate, then the Ploughman, by lifting up his Plough, must pass over it, until he meets with Mould again; and so must the *Sembrador* also be lifted up, the Weight whereof being but very little, and no considerable Trouble to the Ploughman.

4. When the Clods and Stones cannot be master'd with only one Pair of Ears,

Ears, you must add another Pair of them to the Plough, 4 or 5 Inches higher than the first (choosing a fit Place in the Beam to place them in) although behind the others a little; for so the *Sembrador* will be perfectly saved and defended: And the second Ears are to be of the same Bigness with the first. And this is found, by Experience, to be the best Remedy against the Stones and Clods.

5. The time of sowing, according to the most experienced Farmers, is when the Mould of the Land is dry, or but a little inclining to Moisture: In either of which Conditions of the Land, this new *Sembrador* works without clogging the Wheels, or stopping up with Dirt those Holes thro which the Grain is to issue forth.

6. When this *Sembrador* works as it ought to do, it will sow three *Celamines*, or about a Peck of Wheat, and five *Celamines*, or $\frac{1}{12}$ of a Bushel of Barley, on as much Land as would take up about $1\frac{1}{2}$ Bushel after the common way of sowing. And if it much exceed or fail of this Proportion, it noteth some Fault in the Instrument, or Carelessness in the Plowman.

7. The Spoon must be made for all Seeds, proportionably to their Bigness.

8. You must plow the Furrows very close one to another, that so the Plough when it turns back may the better cover the last Furrow, which is left open, and sowed as it came along.

9. After having sown the Land, in the same manner the Land should be made as plain as can be, and no such Furrows made to carry away the Water as hitherto hath been used: But it will be sufficient, that at every 4 Yards distance (one from the other) Furrows be made. For Experience hath taught us, that the Land laid up without Furrows bears more Corn, than that which hath more Furrows, because the Wheat and Barley, and other Plants, receive greatest Damage by Drought; and therefore this ought more especially to be observed in *Spain*, one of the dryest Countries of *Europe*.

10. In many Parts of *Spain*, in 1664. it was found, that Land sown in *September* hath yielded a better Crop, than that which was sow'd in *October*; and that sown in *October* better than that sown in *November*; which proveth, that 'tis more advantageous to sow early than late.

11. They have observed also, that it is very profitable to sow in the new Moon, because it will shoot forth, and thrive, and ripen sooner. In *Spain*, *Italy*, and the Islands of the *Mediterranean*, they may begin the first new Moon in *September*, and so go on, and end with the new Moon in *November*: But in *Germany*, and the low Countries, they begin in the end of *August*, and end with the new Moon of *October*.

LXXXI. It is vulgarly known, that the Surface of some Ground is so hollow, light, and swollen by a hot and working Ferment, that it must needs send up a warming Steam, as appears by the quick Riddance of all the Snow that

*Agrerick
Observations
and Improvements,
by Dr. J.
Beal. n. 116.
P. 359.*

that falls on it, and (in many Places within my Knowledge) dissolving the Snow before it falls on the Ground ; that some Stones by an innate Warmth, and some Waters do impregnate the Earth, and that other Stones by their contrary Qualities or by their Positions, have a quite contrary Operation ; that Streams of Water running over Lime-stones, or thro Veins of Marle, or of that sort of Chalk which is kind for Manure (for there is a sort of Chalk which is barren) doth fertilize ; that some other Waters are hungry, uliginous and corrosive ; and that those Rivers which are filled with a black Water, by Rain running over Heaths, do much Mischief where they overflow, begetting Heath all over the Pastures.

In the sharpest Frost that I have known these many Years, the Ground having been also some Days covered with Snow, I saw a small Stream (no bigger than might run from the Mouth of an ordinary Quart Glas-bottle) sliding merrily, and smoaking all the way over the Lawns. I could not discern, that any Snow had fallen within 5 or 6 Foot on each side ; (if it did, none remained there) and so far the Grass at that time, about *Christmas*, was as green as any Leek, and the Frost (so far) apparently dissolved. Of this I then wrote to our worthy Friend Mr. *Evelyn*, not for any Wonder (for perhaps there are, or may be, thousands of such smoaking Streams in *England*) but only representing how such a Stream may warm a Mansion, and cherish tender Evergreens well shelter'd from Winds, and flowry Gardens, all the hard Winter, and do us better Service in an extreme hot Summer. I have been perplex'd in observing my self, an hundred times, the difference of Heat and Cold between two Villages within a Mile of each other, where we could observe no disparity of Hills or Rivers ; only the Springs in the one were all shallower, in the other some were deeper. In a large Tract of Land the Surface was of so hot a Ferment, that at every Step I trod up to the Ankles. I caused it to be examined by the Spade, and found it, as far as I tried here and there, at a Foot depth, as thick set with Pebble-Stones, as if a Causey had been pitch'd there, yet was it a quick and pregnant Land for Flowers, Fruit-trees, and Vines, these Pebbles being dislodged, and some of them carried away. I have seen Fields where the Surface did seem covered with Pebbles, not flinty nor Limestone, yet they bore full Burdens of the best and cleanest Rye and Oats : The Husbandmen took away the Pebbles from off the Surface, and then the Land bore as strong Wheat, Pease and Barley, as before it bore Oats and Rye. In other parts where I have been, the Husband-men took away the Stones which seemed to cover the Fields, and sustain'd great Loss for their costly Labour ; there Corn was much weaker for some Years after. I can attribute these differing Events to nothing, but the Difference of Stones : some intrinsically warm, and impregnating above Ground, some cold and not impregnating, whilst in that Position or Situation. Yet some Experience forbids me to deny, that even such Stones, when covered with Earth, at a certain Depth, may increase the Fertility of the Land. And the hot and bibulous Land, which drinks up the Rain and Snow as soon as it falls, seems to have some cooling Refreshment from underground Pebbles, which are of a cold, stiff, and sullen Nature.

What

What I have to say of warming and fertilizing Rocks, I shall deliver with an aspect towards *Scotland*, for *Horticulture*. I had several times Conference with Sir Robert Morray B. M. (who was an Honour to his Country, and a Blessing to the Place where he abode) concerning esculent and olitory Gardens, and in one, Nurseries of Fruit-trees, and other useful Vegetables in *Scotland*. I represented, that, almost within my Memory, they are become the chief Relief of *England*, that 'tis lately found that austere Fruit yields strong and sprightly Liquor, which resembles the Wine of the Grape, that the Return of Gain from Gardens is great and speedy; Nurseries neither a chargeable nor a burdensome Addition, but a congruous Engagement of the Multitude to persevere in the noblest kind of Agriculture. Sir R. M. granted all that I said; and I am sure, he acted and executed all that he could for the good of his own Country, and for *England*, &c. But saith he, there are so many Rocks, and such bleak Winds in *Scotland*, that they can hardly draw in the same Yoke with *England* for Gardens and Orchards. I replied, that in *Devon* and *Cornwall* they fenced their Gardens and Orchards with *Flanders* Furze and tall Holly from the Sea-winds; and they have lofty Firs and goodly Pines in *Scotland*: and *New-England*, where the Winds are as keen, and the Snow and Frost as deep, and as long lasting, as in many Parts of *Scotland*, is yet full of fruitful Orchards. And if *Scotland* be farther in the North, yet *Norway* is rich in *Boscage*; and the Seeds of the Hemlock-Tree, Spruce and Cedars, from *New-England*, *New-found-Land* and *Virginia*, may perhaps rejoice in the Exchange of *Northern America*, for the North of this Island.

This I told Sir R. M. I durst undertake, that when *Edinburgh*, and their Towns and Universities, shall plant Kitchen-Gardens, as we do now in *England*, they shall receive their grateful Reward the first Year, and bear the Charges of their Nurseries abundantly, and so hold on; and within 7 Years, secure their Posterity of the Benefit, and delight themselves with the Fruit of their pleasing Labour.

Now for fertilizing Rocks, I made bold to repeat it often, That within a Day's Journey of the Heart of *England*, I could shew 3 Gardens, the best that I have seen for flowry Beauties, *English* Ever-greens, and Sallads, all the Winter long; all these on a hard Rock, in most Places but one Foot deep under Earth; in some two, in few Places 3 Foot deep; very lofty Hills close on the South-side, the Declivity of the Gardens due North, and the Rock perfectly bare next to the Walls on the North-side. And I saw rich Hop-Yards in the same Case, but in deeper Ground, next to the Garden on the South-side of the Garden; and these Northern Hop-Yards escaped many Blasts, which seiz'd on the Hop-Yards on the South-side of the Hill. On the steep ascent, on the North-side of one of these rocky Hills, where no Plough could come, I saw a Gentleman plowing up the shallow Turf with a Hand-plough for Flax; and I saw good Flax grow there, to the Largeness of a Village-Field. His Hand-plough had a Stem of Ash or Sally, about 7 Foot long, and a Plate on one Side near the End, to turn the Turf; a Coulter to be let out shorter

or

or longer, to cut the Turf 4 or 5 or more Inches deep, as the Land affords it; and a small Iron Wheel. This Hand-plough the Master and his Man by turns drove before them with a walking Speed; having Leathern Aprons before them to save their Clothes. For the Causes of this hardy Fertility *viderint Philosophi*. I am sure of the Truth of what I write, and I am willing to apprehend, that if in *Scotland* they did, in fit Places, sow the best Flaxseed of *Flanders*, as many here do, they would make good *Holland* Linen, Lawn, and Cambrick, as now they do *Scotch* Cloth.

It is no hard Task to shovel down the shallow and mossy Turf, from the steepest Declivities of Rocks, into Places where it may have some Receptacle or Stay, and there to impregnate it with the Spade and Compost, for Gardens or Vineyards. And there the tenth Part of an Acre in Gardening may yield more Profit than 10 Acres of ordinary Tillage in a Corn Field.

I am so much a Stranger to *Scotland*, that I cannot say, whether Saffron, Liquorice, Hops, Madder, Oade, or what other rich Commodities do prosper there; but this I know, that our *English* Saffron and Liquorice do far excel all the foreign, which our Druggists do sell us from the *South*. And since Vines and Mulberries have travelled from the remotest *East*, thro all the hottest Countries, and have abundantly enriched our next Borderers, and have received acceptable Hospitality as far as they have been tried, in this our Island; we have Encouragement enough to adventure the cheap and easy Trial.

Some of my Correspondents tried the Mulberry and Silkworm as far in the North as *Huntingdonshire* and *Cheshire*, and Sir James Craig tried them in the moistest Place of *Ireland*, in the County of *Cavan* in *Ulster*; and all boasted of their Success, *An.* 1651, 52, 53, 54, 55. Wherever Mulberries grow, I am apt to expect, that the Worms will live, and spin, and furnish the Silken-Trade.

In *Devonshire*, they mingle black Mulberries fully ripe, with a full-bodied Cyder, in the time of grinding or pressing the Apple, with Discretion for Tincture and Relish: And they esteem it a very wholesome and stout Wine.

*Vid. Sup.
Sect.
LXXIX. 2.*

'Tis strange, that in 9 or 10 Years since this was published, the Practice hath not been spread into other Countries, where they abound with strong and winy Cyder; many being willing that their Cyder should in Tincture resemble Claret, Tent, or *Alicant* Wine. But it may seem, that we do yet retain somewhat of our Fathers Averseness to planting Mulberries, which they shewed near the Beginning of King James's Reign, to our great Loss and Shame.

The Mulberry requireth a rich, succulent and rank Ground, which is not wanting in the Approaches of any of our Cities and Towns. And Mr. Evelyn hath written as well as can be written, both to instruct and to encourage the planting of them.

The white Mulberries (as we call them) are for the finest Silk; but to mingle with Cyder, and for our Junkets, (as *Palladius* hath hinted to us) we should send for the most delicious black Mulberries which may be had in *Naples*,

plex, Sicily, Virginia, or any of the *East* or *West-Indies*, not trusting to the *Seed*, but by all Means to have young Plants, of the best sorts, sent in Boxes containing some of the connatural Soil. Thus if the Gardens about London were well furnish'd, they might easily be dispersed into other Parts, without more ado: For, few Plants may be more easily propagated, when they are young. A few rooted *Mulberries* being pressed down, and covered with Earth in fit Places, so that the Eyes may be very lightly covered, and the *Sprouts* or *Branches*, if there be any, may be cut very near to the Ground; or a good *Branch*, after due depth of the bigger End in the Rich Mould, thus ordered as before, will soon become a perpetual *Nursery*; And if the worst *Mulberries* were well dispersed, they may be soon amended, by putting the largest black *Mulberry* upon that of the small kind; it being certain that it takes better upon that than upon the white *Mulberry*.

Vinous Shrubs are now coming into Fashion, of these do some make *Sugar Wines* by Art, to be compared (for Wholsomness and Pleasantness, to many Palates) with Rich Wines of the *Grape*. For the *Sugar-Cane* doth hardly yield to any Vine in the World: and we hope that *Meath*, *Metbeglin*, and other *Honey Drinks*, will in a short time give Place to these *Sugar-wines*, when perfectly well made.

Besides, 'tis good Employment for the poor Women and Children to gather the Fruit, and a special Improvement of our waste Lands and Heaths, only by turning the Turf and burnt Heath (if there be any) into the *Trenches* and *Pits*, made by the Plough or Spade, for *Banks* or *Beds*.

Many discourage themselves from *Planting Cyder Orchards*, saying, that if they had the Fruit, they should yet want many Matters, too costly for them. For their Sakes, I shall here instance, that in all the Neighbourhood round about *Teoville* in *Somerfetshire*, they, that make 20 Hogsheads of *Cyder* yearly, and much more, do pound all their Fruit in *Troughs*, made for the purpose, deep and strong, with *Broad Footed Pounders*, one, two, or three, as their need requireth, pounding together in the same Trough. And to me they hold the Paradox stoutly, that without more Cost or Trouble, this is the best and cheapest Way. Workmen are cheaper in the Country at some Season, than in some Cities. And 'tis a Charity to employ Men that want Employment, rather than Beasts; and sometimes 'tis unsafe to trust either to the Wind, or to the Water.

Cyder, you know, costs no Fewel to brew it, and the Labour is but once in the Year.

'Tis drawn by divine Chymistry, so many *Trees*, so many huge *Alem-acks*, which attend to that divine Work constantly all the Year, they need no *Furnaces* to send forth a corroding Smoke to choke all the City, to strangle them into Consumptions, and to corrupt all Beauties and Amenities. Neither *Iron*, *Steel*, nor *Marble*, can resist the Fumes of *Brewing-Houses*: where *Cyder* is of a thousand Kinds, proper to cure many Diseases, and a kind vehicle for any Healing Vegetable, or other medical Matters.

The *Cyder* of the best *Pepins* duly ripen'd and kindly fermented, is a peculiar

culiar Remedy for the *Consumption*, and generally all strong and pleasant Cyder exciteth and cleanseth the Stomach, it strengthneth *Digestion*, and infallibly frees the *Kidneys* and *Bladder* from breeding the *Gravel* and *Stone*. This is (above all) the peculiar Excellency of the right *Red Strake* of *Ircbin Field*, when it escapes all Sophistications. But that which makes Cyder fit to accompany the *Trades men's Granary* is, that if it be made of right Cyder fruits, so that it will be full bodied and strong, it will hold good without decay, and will yearly be much improved for some Years, to the next plentiful Year, as usually it falls out, and best of all in large Vessels, the larger the better. *Tradesmen* should not be for bottled Cyder, which is commonly more windy than healthful. It hath been tried from my Childhood in Vessels of 14, 15 or 16 Hogsheads, of the free Household Measure, containing 60 or 70 *Statute Gallons*; I have been often told, that Sir *John Winter* had a Vessel which contained 30, or at least 28 Hogsheads.

When the Citizens shall ordinarily drink Cyder well diluted, as the French drink *Wine*, and as the sober People in all our Cyder Countries drink their *Washings* of Cyder, as they call it, or Cyder well diluted in the *Grinding time*, and as they drink in *London* their 6 *shilling Beer*, I am perswaded it will much conduce to their Health; and I have often heard labouring People affirm, that they are more strengthened for hard Work by Cyder largely diluted, than by very good Beer.

Yet I have much more to say for *Household Gardens*, as a fit Match for *Granaries*. *Coleworts* and *Cabbages*, with a little Care, hold out 7 or 8 Months in the Year. We have them all the Year round; good Sauce for *Bacon* as red as any *Rose*, as they have it in *Herefordshire*, where the Swine will get a Share of the Fruit which fall from their Hedges, and the *Bacon* of *New-Forest* is generally commended. These are in good Houses always at hand, and may be easily dressed without Waste of much Time. But Roots of all sorts, *Rapes*, *Turneps*, *Carrots*, *Parsneps*, *Skirrets*, *Potatoes*, do challenge the Precedence before *Granaries*; they are a kind of *Under Ground Granaries*, and do often times hold out, when Corn faileth; especially the *Potatoes* of *Barbadoes*, or of *Virginia*.

The *Potatoes* of *Barbadoes*, in our fresh Memory, relieved *Ireland* from two *Years Famine*, when their Corn fail'd there; as *Chestnuts* relieved *France* in the Extremity of their civil War, when their *Ploughs* were forsaken. These *Potatoes* cost little or no Culture for 10 Years together, being only covered with *Fern*, or other light *Muck*, and that turned in with the *Earth*, and 2 or 3 Roots, as often as there is Occasion to take any of them up for Use, and they should be taken up here and there, by small Parcels, where they grow thickest. A few *Acres* of these will run far to furnish a City and the Country round about. They have been sold in the *Markets* of *Bristol* and *Wells*, at the Price of 4 *shillings per Bushel*, dear enough in respect of their easie Propagation and Culture, and cheap enough in respect of their Use. Children of poor People thereabout eat them raw, instead of *Bread* and other Food, without Hurt; some do roast them in *Embers*, as they do *Wardens*; some do boyl them, peel them, and eat them with *Butter* and *Pepper*, either for

ved whole or chopt, as they do Parsneps ; some do strengthen their *Beer* or *Ale*, or make good Drink with them, so they are to them instead of Corn and Malt, and an acceptable *Treat*. Every way they are a strong and wholesome *Nourishment* for *Labourers*. Some do parboil them slightly, peel them, and mince or cut 'em in small Bits, mingle 'em with slices of fat *Flesh*, seasoning all to their *Palate*, and bake them in *Pies* or *Pasties* ; and they esteem them a restorative *Delicacy*, not much inferior to *Artichokes*. I observe 'em to grow and prosper abundantly in much differing kinds of *Soil*, from the *North* of *Shropshire*, to the *Sea Coast* of *Dorsetshire*. But they like not a stiff and strong *Land* : I try'd them 2 Years in a strong *Wheat Land*, and could get no good of them there ; all the *Roots* which were there generated, were little bigger than the *Bulbs* of *Saffron*. In light and hollow *Land* of the *best* *Ferment*, which is commonly of little *Worth* for *Corn* or *Pasture*, these *Potatoes* thrive best and taste best. But now I am at a *Difficulty*, whether the great *Difference* which we find in the *Relish*, be from the differing *Kinds* of the *Potatoes* of *Barbadoes* and *Virginia*, for both have the same *Resemblance* above *Ground* : Or, whether the *Difference* which we find be only from the *Diversity* of the *Soyl*.

That the *Soil* makes a great *Difference*, and that all may be careful to chuse a fit *Soil* for their *Garden-Dyet*, I shall here offer some notable *Instances* to prove it. All the *People* here, (the very *Vulgar*) do find the *Carrots* and *Turneps* or *Rapes*, from the common *Field* of *Marios*, 8 Miles from hence, *Westward* ; far to excel other very good *Turneps* and *Carrots* in *Fatness* and pleasing *Relish*. And *Cabbage Plants* from the wild *Fields* of *Lydiard*, *Westward* of *Taunton*, where they have a rich reddish *Soyl*, do so far excel all other the best *Cabbage-Plants*, that these *Lydiard Plants* are bought in all *Places* at 80 Miles distance ; and *Garden Plants* are sometimes much altered in *Taste* and *Properties*, by the *Accidents* of the *Year*. In a droughy *Summer*, the *Plague* then being hot in *London*, we had *Carrots* in *Northamptonshire* from a kind *Soyl*, where they were wont to be very good ; but then so rank, dry and earthy, that we could not endure to see them on the *Table*.

I hear that the *Turneps* of *Hackney* are better than any other *Turneps* about *London*. We have here very good *Turneps* white and yellow, which are fatter and esteemed more restorative : But all *England* wants the *Bohemian Turneps*, Blood-red on the outside, which are extolled by *Muffet*, as he found them in *Prague*, to be so restorative and delicate, that the *Emperor* himself nurseth them in his *Garden*.

The *Spanish Potatoe* requires diligent *Culture*, much *Sun*, and a light and pregnant *Garden Soil*. In the *Modern Latin* they are called *Glandes malacenses*, being brought into *Spain* from *Veliz Malaga*, a *Province* in *America*. They report, that more than a *Dozen* of their huge *Spanish Ships* were brought at one time to *Sevil* in *Spain*, fully *Fraighted* with these *Potatoes*, and were soon disperst all over *Spain*. We say the *Spaniard* is slow at every thing : But they may say, the *Englishman* in many *Parts* of *England*,

is more flow at the best Improvements of our own Country ; Witness our Want of *Vineyards*, of *Groves*, of *Mulberries*, of the best *Chestnuts*, *Walnuts*, *Figs*, *Almonds*, &c. which are wanting in most Parts, and do not refuse to grow in our Climate.

Improve-
ments of A-
griculture, by
D. M. L. f. r.
p. 205 p. 43

LXXXII. For the Improvement of sandy, light Ground, or any Clay well sanded, I recommend upon Experience *Vicia multiflora Nemorensis Perennis*, sive *Dumetorum* J. B. It hath these Qualifications, beside those mentioned in the Title of *J. Baubine*, viz. of its being *Perennial*, Thriving even in *Woods* and amongst *Bushes*, and being of the *Pulse* or *Pea* Kind, that it shoots 1000 Roots far and wide, and spreads it self under Ground like *quick Grass* ; above Ground it is so rampant, that it will climb a Fathom and half upon Measure, and will preserve it self in spite of *Weeds* or *Drought*. Again, it may be set as well as sown in Furrows, and for this purpose, the Roots may be dug up in *Sept.* as well as the ripe Seed then gathered ; by this means the Growth of it would be mightily advanced, for the older the Roots are, the stronger and fuller of *Buds* and *Shoots* they are. I sow'd the latter End of *March*, the Seeds I had gathered in *Sept.* and had that Year a very great Increase ; the Bed being thick covered over with *Grass* above 2 Foot high ; but it did not flower that Year. I reckoned that one *Pea* had put forth that Year above 30 *Shoots* in *August*. In the *second Year*, it flowered by the middle of *June*, and bore a wonderful Crop, the Roots being innumerable. I have observed this *Pea* very common in all Mountains as well as Plains of *England*, where *Bushes* or *Hedges* are. Both the *Pea* and *Grass* are very sweet, and very agreeable to Cattle, as I have tried.

Agriculture may be also considerably advanced, by the great Choice of Plants, even of those of our own Growth, of the *Pulse* Kind ; of which I recommend this List.

Lathyrus major Latifolius Ger.

Lathyrus Luteus Sylvestris Dumetorum L. n.

Astragalus Sylvaticus Ger.

Vicia Sylvestris Semine rotundo Nigro C. B.

Orobis Sylvaticus nostras C. B. P. in Append.

Vicia Sylvatica Multiflora maxima P. B.

I also recommend as Substitutes of *Hemp* and *Flax* of our *English* Growth, viz. *Perennial* Plants ;

Linum sylvestre Angustifolium J. B.

Linum sylvestre Floribus Cæruleis Ger.

Corona Fratum ; of the *Thistle* Kind. This Plant is generally a *Yard* tall ; its Fibres are exceeding tough and strong, beyond any I ever tried ; it puts forth many of these tall and very thick Stalks yearly ; it naturally grows to this Bulk in most barren Soils, as the dry *Woods*, and high Pastures, in *Yorkshire* and *Lincolnshire*.

It may be objected, that as *Annual* Plants require more Labour and a fatter Soil ; so they recompence it in Largeness of Growth and Fruit : And also that Plants of lasting Roots are more harsh and bitter, and not palatable

for Man or Beast. I answer; that the *Compendium* of Labour, in Husbandry, is all in all; and that therefore the durable Plants will turn to better account: I refer to the wonderful Examples of such as have already been made use of as *St. Foin*, &c. And it is probable, that by some Tillage, even *barsh* Plants may be improved and brought to be kinder Food. The same *Asparagus* which we eat, grows wild in the *Marshes* of *Lincolnshire*, very fair, and not to be distinguished by the Eye from that in our Gardens; but is intolerable bitter, which Garden Culture alone has Civilized and made pleasant to the Taste. For this Purpose, Liming of Pasture-Ground makes it palatable to Cattle: For cast *Lime* over the one half a Pasture, the Cattle will not bite any where else willingly, and will Eat here to the bare Ground, much neglecting the other half. I did use when I lived in the North, to lime my *Asparagus* and *Lettice Beds*, and this did so far meliorate them, that they far exceeded in *Tenderness*, and pleasant Taste; covering the *Asparagus* in Winter, with clean *Wheat straw*, instead of stony Litter, and sowing the Bed thick with the Powder of *Burnt Oyster-shells*.

Perhaps *White Briony*, of all our *English Plants*, would best succeed both for Hay and Corn, as giving the most *Grass*, if we would that way use it; and also yielding a Root of prodigious Bigness, which seasonably taken up, is little else but a *Mass* of *Fine Flower*. 'Tis true it is a *churlish Purge*, and not fit Food for Man, or any other Animal we keep: But such and much worse is the *Cassava Root*, of which the *Indian Bread* is made, and which by *Exsuccation* and *Baking* alone, proves innocent and wholesome. If the vast shoots it makes be designed for Hay, they are to be cut when tender, and in the Flower.

LXXXIII. Sow all sorts of *Grains*, and plant *Kernels* in Beds of *Earth*, at the very time when the Sun enters into the *Vernal Equinox*, and take them up when they are strong enough to be transplanted, at the Time of the full Moon, which Time is always to be observed, if you will take them up and Replant them again.

But now to know the *Moment*, or very near the *Moment*, of the said *Equinox*, take some Ashes of *Vine Wood*, put them in an earthen Pot Leaded, or a Pot of the white *Earth* of *Fayence*, very clean; pour upon it common Water, or Fountain, or Rain-water, that is very clear, from the $\frac{1}{2}$ of March to the $\frac{1}{11}$ of the same; and at the time when the Sun enters into the *Equinoctial Point*, you will see the *Ashes* make the *Water Turbid*, and then is the Time of sowing your *Grains* and planting your *Kernels*.

LXXXIV. I am of Opinion, that one considerable way to improve Gardening, and the Culture of Plants, would be to give a Description of the Plants themselves, then the *Soils*, *Climates* and *Countries*, where the *Vegetables* to be cultivated naturally grow; and what Seasons, Rains and Meteors they have: Which being imitated, as much as possible, perhaps some Plants

To make
Plants grow
to an extra-
ordinary big-
ness, by M.
D. 116. p. 356

Gardening
improved, by
Mr. H. Soane
p. 119

Plants might thrive better, than now they do in the fatteft Ground. And to this purpose, I have been assured by an honourable and very ingenious Person, that he has known some *Plants*, particularly *Centaureum Minus*, which not growing the ordinary way, was tried by dropping the *Seed* on the surface of the *Ground* amongst the *Grass*, by which *artificial Imitation* of *Nature*, it came to Perfection, which no other Way could be brought about.

The success
of a new
Stove, by Sr.
Dudley Cul-
lum, n. 212
p. 191.

LXXXV. I have made a Stove for my *Green-house*, according to Mr. Evelyn's late Invention, published in the *Calendarium Hortense*. I laid my Pipes of *crucible Earth*, not too near the *Fire-Grate*, which is about 16 *Inches*, and I made a *Trench* the whole length of my House, under the *Paving*, about 18 *Inches* in *Breadth* and *Depth*, covered with an *Arch* of *Bricks*, and at the other End of the *Trench*, having an *Iron-Plate* about 18 *Inches* square, to take off, and put on, with a round Hole at each Corner, of about 3 *Inches* *Diameter*, with a Lid to slide open and shut, so that by opening any of these Holes, or all of them, more or less, or taking off the whole Plate, I can release such a Quantity of Air out of the House, to blow the *Fire* so as to increase or diminish the Blasts; and as Mr. Evelyn was pleased to inform me by a Letter, concerning distributing the Air at its Admission, more equally through the House; I inserted my Pipes into a Channel all along the *Wall*, at the End of the House, with those several *Overtures* he mentioned, all which prove admirably.

To make
Fruit and
Flowers
grow in
Winter, by
Sr. Robert
Southwell,
237. p. 44.

LXXXVI. Take up *Trees* by the Roots in the *Spring*, just as they put forth their Buds, preserving some of their own *Earth* about the Roots, set them standing upright in a Celler until *Michaelmas*, then put them into Vessels, with an Addition of more *Earth*, and bring them into a Stove, taking care to moisten the *Earth* every Morning with *Rain Water*; in a Quart of which, you must dissolve the Bigness of a Walnut of *Salt Armoniack*, and about Lent, *Fruit* will appear.

As to Flowers, Take good earthen Pots, and therein sow your Seed at *Michaelmas*, Watering it in the same Manner with the like Water, and by *Christmas* you will have Flowers, as Tulips, Lilies, &c.

This and the other may be done in a good warm Kitchen; and, such Days as the *Sun* shines, you may set them forth for some Hours.

To keep
Fruit and
Flowers the
whole year,
by Sr. Rob.
Southwell,
n. 237. p. 44.

LXXXVII. Take *Salt-Petre* one Pound, *Pole Armoniack* two Pounds, ordinary clean Sand 3 Pounds; mix all together, and observe this Proportion in other Quantities.

Then in *dry Weather*, take *Fruit* of any sort that is not fully ripe, each with its Stalk; cut them in, one by one, into an open Glass till it be full, and then cover it with an *Oily Cloth*, close tyed down; then in a dry Cellar, put each of these Glasses 4 Fingers under Ground, and so as that quite round each Glass, and above and below, there remain 2 Fingers thick of the said Mixture.

Flowers also may be used in the same Manner.

LXXXVIII. I

LXXXVIII. I would advise such as suffer *Detriment* in their *Green Houses*, Remedies for decayed E. ver greens. by Mr. J. Evelyn, n. 158, p. 561. not to despair, when they see the Leaves of their *Myrtles*, *Oranges*, *Oleanders*, *Falmines*, and other precious *Fruits*, *Russet*, or altogether shrivelled and falling, but to cut them to the *Quick*, plaister the Wounds, and plunge their *Cases* and *Pots*, trimmed with fresh *Mold*, &c. in a warm *Bed*, carefully refreshed, shaded, aired, and treated as sick *Patients*, and as the prudent *Gardner* best knows how. But above all, that he be sure not to expose them, 'till the *Eastern Winds*, which I call our *English Etesians*, and which make our *Springs* so uncomfortable, when we think *Winter* and all *Danger* past, be qualified; for they are deadly to all our *Plants* abroad, and frequently do us more *Prejudice* than the most churlish *Winters*, as commonly finishing the *Destruction* of what the *Frosts* have spared. Nor are we to be flattered with a warm *Day* or two, which are apt to tempt *Gardeners* to set out their *Plants* before the End of *April*, or that we find the wise *Mulberry* put forth, which is certainly the most faithful *Monitor*; nor should we indeed cut or transplant any of the *Perennials*, till of themselves they begin to sprout.

LXXXIX. In the *Spring*, being flattered with some warm *Glances* and refreshing *Days*, many are apt to expose their choise *Greens*; which, upon a sudden *Change* to its former cold with sharp *Eastern Winds*, proves more pernicious to such *Strangers* than all the former *Winter*, and seems to finish the *Destruction* of what the former *Cold* had spared, a *Matter* too frequently seen among us, we enjoying no certain steady *Summer* till after the *Solstice*. But these tender *Exotics* losing their *Leaves*, having received *Detriment*, with their *Tops* shrivelly and the like, are oftentimes not capable of enduring the interposing scorching *Heat* of the *Sun*, which oftentimes happens by *Fits* in the *Spring*; when the *Prudence* and *Care* of the *Gardener* is especially tried, gradually to help and recover his sick *Patients*, sometimes by due *Trimming*, *Earthing* with fresh *Sustenance*, loosening the strait bound *Earth*, and sometimes with the help of a warm *Bed*, and gentle watering and shadowing, and the like, patiently and carefully waiting the *Return* of the *Bounty* of the *Heavens* to help his *Endeavours*. Cautions about exposing Ever Greens, by Mr. Jacob Bobart, n. 165, p. 777.

In the *Flower Garden*, especial *Observance* ought to be taken of the choicer *Roots* of the *Asian Ranunculi*, *Aulmoneys*, tender *Narcissi*, and divers others of the like *Tendernels*, and *Strangers* to such *Entertainments* as our *Northern Countries* afford; that if hard *Frost* should happen, they should be securely covered and kept from the *Frost*, if possible, till the too frigid *Moisture* of the *Earth* be digested, which would prove pernicious; even to the *Death* and *Rottenness* of many such *Roots* and *Plants*. Vid. sup. cap. 1. §. LIII.

XC. Papers of less General Use, Omitted:

- n. 20 p. 791. 1. **D**irections for Transporting Vegetables.
- n. 20 p. 39. 2. **P**hytologia Tingitana; or an Alphabetical Catalogue of Plants growing within the Fortifications of Tangier, 1673. by Mr. Spotswood.
- n. 231 p. 677. 3. A Catalogue of some Guinea Plants, with their Native Names and Virtues; sent by Mr. J. Smith, from Cabo-Corso, with Remarks on them, by Mr. James Pettiver.
- n. 244 p. 313. 4. An Account of 46 East Indian Plants, Collected at Unamercoonda, about 12 Miles from Fort St. George; by Mr. Sam. Brown, with their Names, Descriptions, and Virtues, by Mr. James Pettiver.
- n. 236 p. 1. 5. An Account of Part of a Collection of curious Plants and Drugs, gathered by Mr. Sam. Brown, a Physician at Fort St. George, in the East-Indies, and lately given to the Royal Society, by the East India Company. With Remarks, by Mr. Pettiver.
- n. 254 p. 179. 6. Quarries concerning Indico, by —
- n. 267 p. 699. 7. Quarries concerning Vegetation, especially the Motion of the Juices of Vegetables, by —
- n. 193 p. 204. 8. Quarries concerning the Circles of Wood in the Bodies of Trees, and the Motion of Sap, by Dr. Ez. Tonge.
- n. 40 p. 797. 9. Quarries concerning Vegetation, and the Motion of Sap in Fruit-Trees, by Dr. Ez. Tonge.
- n. 43 p. 858. 10. Quarries concerning Vegetation, and the Motion of Sap, by Dr. Ez. Tonge.
- 862 n. 46 p. 919. 11. Enquiries, about Retarding the Ascent of Sap, and the Motion of Sap, by Dr. Ez. Tonge.
- n. 44 p. 881. 12. Some further Enquiries concerning the Running of Sap in Trees, colouring the Fruit and Leaves, multiplying Crabstocks, and propagating Trees by Layers, &c. by Dr. Ez. Tonge.
- n. 46 p. 914. 13. Enquiries relating to the Circulation of Sap in Trees, by Dr. Martin Lister.
- n. 70 p. 2121. 14. An Enquiry suggested from Italy, whether it be likely to find something in Plants, analogous to the Heart in Animals.
- n. 74 p. 2218. 15. An Invitation to make further tryal of the Juices of Trees, by Tapping them, by Mr. H. Oldenburgh.
- n. 100 p. 801. 16. Two Problems concerning the Texture of Plants, and the Discovery of Poyson by *Ogium*, proposed by —
- n. 252 p. 186. 17. Enquiries concerning Agriculture, by the Committee of the Royal Society, for considering of Agriculture.
- n. 5 p. 91. 18. Enquiries concerning the Use and Culture of the Kitchen Garden, and Winter Greens by —
- n. 40 p. 799

XCI. Accounts of Books, and Additions,
Omitted.

1. **B**asis Botanica: Seu brevis ad Rem Herbariam Manuductio, omnes Plantarum Partes, una cum earundem Virtutibus secundum Novissima Botanica Fundamenta, Generali quadam Methodo commonstrans; a D. Christiano Ludovico Welchio. Lips. 1697. in 12o. n. 243. p. 302
2. Abr. Couleii Angli, sex Libri Plantarum, Poemate Latino conscripti, n. 36. p. 716 Lond. in 8o.
3. Prælia Botanica Roberti Morison, Scoti Abredonensis, Lond. 1669. in 8o. n. 45. p. 934
4. Dr. Morison's New Universal Herbal.
5. Cl. Salmafii Præfatio in Librum de Homonymis Hylæ Iatrica. Ejusdem de Plinio Judicium. Divione An. 1668. in 4to. n. 114. p. 127
n. 46. p. 535
6. Quadripartitum Botanicum Simonis Pauli. Med. Reg. in Dania Argento-
rati, in 4to. n. 76. p. 2291
7. Waare Oeffening der Planten, door Abraham Munting, M. D. Amsterd. 1672. in 4to. n. 121. p. 247
8. Memoires pour servir a l'Histoire des Plantes; dressez par M. Dodart. Ph. col. n. 1;
p. 89. M. D. Paris, 1679.
9. Historia Plantarum, species hæcenus editas, aliasque insuper multas noviter inventas & descriptas complectens. Auth. Joh. Rai, e Soc. Regia. n. 186. p. 283 Lond. 1686. in Fol.
10. Phytographia; by Leonard Plukenet, M. D. Lond. 1691. in Fol. n. 193. p. 528
11. Almagestum Botanicum; S. Phytographiæ Plukenetianæ, Onomasticon, &c. n. 196. p. 618 Lond. 1696. in Fol.
12. Catalogus Plantarum Angliæ, & Insularum adjacentium tum Indigenas, tum in Agris passim Cultas complectens. Opera Jo. Raii, M. A. 1670. in 12o. & 1677. in 8o. n. 225. p. 434
n. 63. p. 2058
n. 133. p. 834
13. The American Physician; or a Treatise of Roots, Plants, Trees, Shrubs, Fruits, Herbs, &c. growing in the English Plantations in America: Whereunto is annexed, a Discourse of the Cocc-Nut-Tree, and the use of its Fruit. By W. Hughes, Lond. 1672. in 12o. n. 83. p. 4078
14. Catalogus Plantarum quæ in Insula Jamaica sponte proveniunt, vel vulgo coluntur; cum earundem Synonymis, & Locis Natalibus; adjunctis aliis quibusdam quæ in Insulis Maderæ, Barbados, Nièves, & Sancti Christophori, nascuntur. Seu Prodomi Historiæ Naturalis Jamaica Pars prima. Aut. Hans Sloane, M. D. 1696. in 8o. n. 221. p. 93
15. Icones & Descriptiones Rariorum Plantarum Sicilia, Melitæ, Galliæ, &c. Italia; Auth. Paulo Boccono, 1674. n. 104. p. 87

- n. 247. p. 462 16. *Museo de Pianta Rare della Sicilia, Malta, Corsica, Italia Piemonte e Germania, &c.* di Don Paolo Boccone, &c. To which are here added some Remarks by Mr. J. Ray.
- n. 145. p. 100
n. 198. p. 682
n. 200. p. 262
n. 214. f. 276 17. *Hortus Indicus Malabaricus, continens Regni Malabarici apud Indos Celeberrimi, omnis generis Plantas Rariores, Amstel. An. 1678. 1679. 1682. &c.* To which here are added some Remarks by Tancred Robinson, M. D.
- n. 236. p. 29 18. *Hortus Medicus Amstelodamensis, sive Plantarum tam Orientalis quam Occidentalis Indiæ, aliarumq; Peregrinarum Descriptio & Icones; Autore Johanne Commelino; Latinitate donatus, Notis & Observationibus illustratus a Frederico Ruyschio, M. D. Botan. Profess. &c. & Francisco Kiggelario. Amst. 1697. Here are many Additional Remarks by Mr. James Pettiver.*
- n. 249. p. 63 19. *Paradisus Batavus, continens pius centum Plantas, &c. With Additional Remarks by Mr. Jo. Ray.*
- n. 199. p. 729 20. *Catalogus Plantarum Horti Academici Argentinenfis in Usus Rei Herbariæ Studioforum; adcurante Marco Mappo, M. D. Argentorati. 1691. in 120.*
- n. 245. p. 385 21. *Histoire des Plantes qui naissent aux environs de Paris; avec leur Usage dans la Medicine; per M. Pitton Tournefort, M. D. a Paris 1698. in 80.*
- n. 265. p. 651 22. *Flora Noribergensis, &c. Being a Catalogue of such Plants as not only grow Spontaneously about Nuremberg, but also of such Exoticks as the Physick Garden of that City hath lately Raised; with the Figures and Descriptions of many of the most Rare, by Jo. George Volkamer, M. D. 1700. in 4to.*
- n. 81. p. 4027 23. *Plantarum Umbelliferarum Distributio Nova per Tabulas Cognationis & Affinitatis, ex Libro Naturæ Observata & Detecta; a Rob. Morison, Med. & Prof. Bot. Regio, &c. Oxonii, 1672.*
- n. 74. p. 2235 24. *De Absynthio Analecta, per Joh. Michael Febr. M. D. Lipsiæ, 1668. in 80.*
- n. 74. p. 2236 25. *Crocologia, Auth. Joh. Ferdinando Hertodt. M. D. Jenæ. 1671. in 80.*
- n. 125. p. 621 26. *Cochlearia Curiosa, or the Curiosities of Scurvygrass; written in Latin by Dr. Andr. Molimbrochius of Leipzig, and English'd by Dr. Tho. Sherly, Lond. 1678. in 80.*
- n. 167. p. 870 27. *Joh. Nicolai Pechlini, M. D. Theophilus Bibaculus; sive de Potu Theæ Dialogus Fran. 1684. in 4to.*
- n. 211. p. 150 28. *Epistola de Generatione Plantarum ex Seminibus, a Josepho de Aromataris. Frankf. 1625.*
- n. 78. p. 3037 29. *The Anatomy of Vegetables begun: with a general Account of Vegetation founded thereon, by Neb. Grew, M. D. F. R. S. London, 1671. in 12mo.*
- n. 97. p. 6131 30. *An Idea of a Phytological History propounded, together with a Continuation of the Anatomy of Vegetables, particularly prosecuted upon Roots, and an Account of the Vegetation of Roots, grounded chiefly thereupon, by Neb. Grew, M. D. & F. R. S. London, 1673. in 80.*
- n. 120. p. 486 31. *The Comparative Anatomy of the Trunks of Plants; together with an Account of their Vegetation grounded thereupon, by Neb. Grew, M. D. in 8vo.*

32. The *Anatomy of Plants*, with an *Idea of a Philosophical History of Plants*: n. 150. p. 303
and several other Lectures, read before the R. Society; by *Neb. Grew*, M. D.
1682.
33. *Marcelli Malpighii Anatome Plantarum*; cui subjungitur, Appendix, n. 117. p. 401
iteratas & auctas ejusdem de Ovo Incubato Observationes, continens. Lond. p. 38. n. 1
1675 & 1679 in Fol.
34. The *Posthumous Works of S. Malpighi*. In this Account of them, S. n. 226. p. 320
Jean Marie Lancisi gives an *Encomium* and *Character* of the Author.
35. *Marcelli Malpighii Philosophi & Medici Bononiensis, e Regia Soc. Lond.* n. 228. p. 548
Opera Posthuma: Fig. *Aeneis* illustrata; quibus præfixa est *Ejusdem Vita*, a
Scipio scripta. Lond. 1697. in Fol.
36. A *Philosophical Discourse of Earth*, relating to the *Improvement of* n. 119. p. 454
it for *Vegetation* and the *Propagation of Plants*; by *J. Evelyn*, Esq; Lond.
1676. in 8vo.
37. The *Epitome of the whole Art of Husbandry*: with *Additions of* n. 114. p. 330
New Experiments thereto belonging; *Written by J. B.* Lond. 1675. in
8vo.
38. *Systema Horticulturæ*: containing in *English*, the *Art of Gardening*, in n. 136. p. 322
3 Books, by *J. W. Gent.* in 8vo.
39. *Sylva & Pomona*; by *E. Evelyn*. Esq; Lond. 1669. in Fol. n. 22. p. 358
40. *Dr. Richard Sbarrook's History of the Propagation and Improvement* n. 53. p. 1071
of *Vegetables*, by the *Concurrence of Art and Nature*. Oxon. 1672. in n. 8. p. 5002
8vo.
41. A short and sure Guide in the Practice of *Raising and Ordering of* n. 86. p. 5049
Fruit Trees; by *Fran. Drope*. B. D. Oxon. 1672.
42. *The Garden of Eden*; or an Account of the *Culture of Flowers*, and n. 113. p. 302
Fruits now growing in *England*; with particular Rules, how to advance
their Nature and Growth as well in *Seeds* and *Herbs*, as in ordering of
Trees; by *Sir Hugh Plat*, in 8vo.
43. *The Planters Manual*: being Instructions for the *Raising, Planting,* n. 116. p. 373
and *Cultivating* all sorts of *Fruit Trees*, whether *Stone Fruits*, or *Pepin-*
Fruits, with their *Natures* and *Seasons*. Very useful for such as are
Curious in Planting and Grafting; by *Charles Cotton*, Esq; Lond. 1675. in
8vo.
44. *Nurseries, Orchards, Profitable Gardens, and Vineyards encouraged*; n. 129. p. 748
the *Present Obstruction* removed, and probable *Expedients* for the bet-
ter *Progress*, proposed; for the general *Benefit* of his Majesty's *Domini-*
ons, and more particularly *Cambridgeshire*, the *Champaign Countries*, and
Northern Parts of England: In several Letters out of the Country; by *Dr.*
J. Beal, and *Mr. Anth. Lawrence*.
45. *The Art of Pruning Fruit Trees*: and a *Traët of the use of the Fruits* n. 168. p. 731
of *Trees* for preserving us in *Health*, or for curing us when we are *Sick*.
Translated from the *French*, Lond. 1684. 4to.
46. *The English Vineyard Vindicated*; by *Mr. J. Rose*. n. 15. p. 62

- n.126.p.646 47. *The French Gardiner*, Reprinted : To which is annexed the *English Vineyard Vindicated*, and the way of making and ordering Wines in *France*, in 8vo.
- n.91.p.6019 48. *Vini Rebnani imprimis Baccaracensis*, Anatomia Chymica, a Job. Davide Portzio Phil. & Med. D: Heidelbergæ. 1672. in 12vo.
- n.69.p.2116 49. Joh. Henr. Meibomii de Cerevisiis, Potibusque & Ebriaminibus extra Vinum aliis Commentarius, annexo Libello Turnebi de Vino. Helmestadii. 1668. in 4to.
- n.123.p.574
n.115.p.352 50. *Vinetum Britannicum* : Or a Treatise of Cyder, and such other Wines and Drinks, as are extracted from all manner of Fruits, growing in this Kingdom : With the Method of Propagating all Vinous Fruit-Trees ; and a Description of a new invented Ingenio or Mill, for the more Expeditious and better making of Cyder. Also the Method of making Metheglin, and Birch Wine. With Copper Plates, by J. W. (Author of *Systema Agricultura*) in 8vo. Advertisements on this Book are here added by Dr. Beale.
- n.124.p.583
n.120.p.644 51. The Manner of Raifing, Ordering and Improving Forest Trees : Also how to Plant, Make and Keep, Woods, Walks, Avenues, Lawns, Hedges, &c. With several Figures proper for Avenues and Walks, to end in ; and Convenient Figures for Lawns ; Also Rules and Tables shewing how the Ingenious Planter may Measure Superficial Figures ; with Rules how to divide Woods and Land ; and how to Measure Timber and other Solid Bodies, either by Arithmetick, or Geometry, &c. by Mr. Cook in 4to.

C H A P. VI.

Zoology.

- Observations in the Rearing of Silk-Worms, by Mr. Edward Digges, p. 2. B. 2. c.
- I. 1. I Have kept Leaves 24 Hours after they were gathered, and flung Water upon them to keep them from Withering : Yet when (without Wiping the Leaves) I Fed the Silk Worms, I observed they did as well, as those fresh gathered.
2. I never observed that the smell of Tobacco, or other Smells that are Rank, did any ways Annoy the Worm.
3. Our Country of Virginia is very much Subject to Thunders : And it hath Thundred exceedingly when I have had Worms of all Sorts ; some newly Hatched ; some half way in their Feeding ; others Spinning their Silk ; yet I found none of them concern'd in the Thunder, but kept to their Business as if there had been no such thing.
4. I have made many bottoms of the Brooms (wherein hundreds of Worms Spun) of Holly : and the Prickles were so far from Hurting them, that even from those Prickles they first began to make their bottoms.

II. Silk

II. Silk; which is the Spittle of a Worm, hath its good or bad Quality from the Nourishment the Worm receives either from a good or bad Leaf. When the Spring proves delightful and sweet, the Worm feeding on a good and tender Leaf, free from the Prejudices of an unkind Season, (which sometimes spoils the Leaf, by giving it a rough, gross, and heavy Nature) then one may expect a Profitable Harvest; and in such Years 'tis best to make a good Provision, for Silk will then find good Sale when most Abundance, and the Buyer meets with that of a good Substance which the Advantageous Season very much contributes to; but not knowing how long it may last, about Midsummer (or *St. John's-Tide*) they begin, in *Piedmont* to draw the *Silk* from its *Cocoon*, to see what it yields, and judge of its Increase or Scarcity, as well as the Estimate of its Goodness and Perfections; those most desirable are, that it proves clean, light, and strong.

To Nature
and Qualities
of Silk; by
Mr. Will.
Aglionby,
n. 252, p. 181

In Case the *Season* should not prove plentiful, then they buy as fast as they can *old Silk*, and keep as much as they can of the other, for the best *Fabrics*; that so they may not be obliged to hazard all their good, at the price of the worst; which is commonly practised: But if the *Season* promise a great and satisfactory Harvest, they take the new, and put it apart for the best *Fabrick*; not despising the old, but only laying it aside till Proof be made whether the new be better or not.

The Goodness of *Silk* is distinguished by its Lightness, as the most Essential Quality; which every Body knows carries a considerable Profit along with it, when bought by Weight, and sold by the Yard or Aune. It is to be noted, that the *Organcine* is *Superfine*, it being the best sort, and No. That the two Threads are equal in Fineness, that is to say, both alike in smoothness, thickness and length, for the Thread of the first Twist: For the second, it matters not whether the single Thread be strong before the two are joyned, unless to see whether the first Twist prove well. It is necessary the *Silk* be clean, the *Straw Colour* is commonly the lightest, and the white the heaviest of all. It is likewise convenient, that the *Skeans* be even, and all of an Equality, which shows they were wrought together; otherwise with great Reason one may suspect that it is *Refuse Silk*, and cannot be equally drawn out and Spun; for one Thread will be shorter than the other, which is Labour and Loss. It will be also requisite to search the Bale more than once, and take from out of the Parcels a *Skean* to make an *Essay*; for unless one buys that which one knows by Tryal, there is a Hazard of being cheated, and so for one sort have another.

To know the
best Silk.

To estimate the *Silk* by *Essay*, fix the *Essay* upon one eighth of a *Portee* of *Silk*, of 110 *Aunes* of *Lyons* in length, and see what it makes of *Aunes* by the eighth Part, the *Skean* which is of 80 Threads, must be Multiplied by 110, which is the Length of the 110. *Aunes*, from which Number must be deducted one eighth; as for Example, 110 by 80. makes 8800. the eighth Part of which is 1100 which is the eighth Part of a *Portee*. Now to Calculate what these 1100 *Aunes* weigh, which is the eighth Part of a *Portee*, or of 110 *Aunes* of *Lyons*, it will be proper to take a *Skean* out of

the
So

the Parcels, which you take from out of the Bale, which you judge may contain at least 1100 *Aunes*, to make the one eighth Part of a *Portee*; which *Portee* must be divided on 2 Bobbins half on each, then fix the 2 Bobbins on the *Cantre* (*Beam*.) and from thence pass it through the (*Combe*) *Hourdissoir*; this done, you cut off your *Silk* and weigh it, and Multiply the Weight by eight, it will weigh just as much as a *Portee* of 110 *Aunes* of *Lyons*: Which is the general Rule of calculating, when they draw the *Silk* out. By this means one may learn to adjust the Weight. There are *Silks* of *Piedmont* which are very light and clean, and to be preferred before any in Sale. The *Portee* of *Silk* of the lightest weighs near 24 *Penny Weight*, to 25 and 26. Others 27 and 28 which *Weight* may be dispensed with, on Condition the other Qualities be as good, to wit, well wrought, even, fine and clean, but above these *Weights* they cannot be, unless they abate of their Profit, proportionable to what they want in lightness.

The Con-
nought
Worm, By
Mr. Will.
Molyneux:
n. 168. p. 876

III. The *Connought Worm* which I find in *Godartius* of *Insects* described by the Name of the *Elephant Caterpillar*, is reported to be the only Poysonous Animal in the Kingdom of *Ireland*. One of them was sent alive to me from the Country, about 40 Miles from *Dublin*: The Gentleman that sent it, had kept it above 6 Weeks in a large Box on a Grassy Sod, now and then giving it a fresh Sod, and *Ragwort* to Eat, besprinkling them with Dew. Some of these Worms are as thick as a Man's Thumb, and above 3 Inches long; and some live so long, as to have fine Hair, thinly dispersed over their Bodies.

The ingenious Gentleman who sent it me is of Opinion, that the Animal is indeed Pernicious, if eaten by a Beast. For first, the Disease, imputed to this Creature, seldom or never affects the Cattle but in *Autumn*, and then; only this Insect is to be found; Secondly, it seldom or never attends any Cattle but what feed in low Marshy Grounds, and there only this Animal frequents; Thirdly, Cows who are greedy feeders by great Morsels (by reason of their Chewing it afterwards in their Cud) but especially *Swine* that feed in low Grounds, are the only Creatures troubled by this Worm; Fourthly, the Worm is very rare, and scarce to be found in 7 Years, and so likewise is the Distemper that proceeds from it; being rare to have a Beast affected by it. As to the Symptoms that attend its *Venom*, they are; swelling in the Head, and (as a Peculiar Characteristick) the *Swelling* and *Procidentia Ani*, in so much that the *Rectum* will hang out above half a Foot. The Effectual Cure applyed to this Malady in *Black Cattle*, is a *Drench* of the Herb *Bears-Foot*, *Rue*, *Garlick*, *Butter* and *Beer*; but for *Swine*, *Raddle* pounded small mingled with *Butter-milk*. These only are used by the *English* Husbandmen. But the *Irish*, as they certainly impute the Malady to this Insect, so they draw the Remedy therefrom: For they assert, that if a Hole be bored in a Tree, and this Creature stopt up therein, so as to starve and dye, the Leaves and Bark of that Tree, ever after, infused in Water, and given as a *Drench*, Cures the affected Beast; and several will repair to such a Tree, 10 Miles for a Cure. Another Fancy (and as ill grounded) they have, that if a Man Bruise this

Worm

Worm between his Hands, and let the expressed Juice dry thereon ; ever after the Water he first Washes in in the Morning, given to the Beast to Drink, Cures it.

But I am very apt to suspect, That this Worm is no more Poyson than other *Caterpillars*. But the Uglinefs of the *Worm* (it being of a Dark, Fuscous, and as they say, Poisonous Colour,) together with its largeness beyond Common *Caterpillars*, has wrought so upon the fearful and Ignorant Vulgar People, that they have given it the Name of *Venomous*. Yet I will not conceal, what I have from another Gentleman, (but with some Diffidence of the Experiment) he gave the Juice of one of these *Worms* to one *Dog*, which shewed no Alteration thereon, but another *Dog*, to whom he gave the Skin of the Creature, was found Dead 3 Days after.

But whether his Death proceeded from the Poysonous Skin, he could not assert ; for the *Dog* ran at Liberty, and might have been kill'd (for ought as he knew) by some other Accident ; tho' no external Sign of any Violence offer'd to him did appear.

AB. is the *Worm*, lying on its Belly, long $2\frac{1}{2}$ Inches almost, c. his Head, Fig. 181; dd. two *Variegated Spots*, mistaken by the People of our Country for *Eyes* ; e. a small Protuberance towards its Tail, from whence arises a part in shape of a Horn, mistaken for a Sting.

Fig. 182. Represents the *Worm* reclined almost on his Back, F. his Mouth formed like that of other *Caterpillars*, as it appeared in the *Microscope*, ggg. Six small *Horny Feet* or *Claws*, three on each side, as in other *Caterpillars* ; Fig. 182. bb. *Eight Papillæ*, with which he fastens himself to what he goes or hangs on, as Childrens *Suckers* are fastened to *Wet-Stones*, ii. two larger *Papillæ*, with which he does both Suck himself fast, and most commonly therewith he grasps the *Stems* of *Grass* and *Herbs*, to which he clings with the other.

IV. The Bearers of Fruit-Trees are full of Asperities, and not so smooth in their Bark as the other Parts of the Tree. If after the Harvest, and any Time all the Winter over, you look upon these Bearers, through an ordinary *Microscope*, you will find the *Cavities* there full of *Eggs*, of an oblong Figure, and Citron Colour, especially in those Years and Trees, wherein the *Caterpillars* have been numerous : Out of these they are Hatcht in the Spring. The Seasons which usually destroy them are, when there comes an early Heat, such as is sufficient to Hatch them, before the coming forth of the Buds and Blossoms, and when immediately there succeeds a Nipping Frosty Air, which soon kills them.

The Discovery of this Manner of their *Propagation*, seems to give light to these Conjectures. 1. That we ought not to conclude, that any *Insects* are Bred of Corruption, and not *Ex Ovo*, because we cannot discern the particular manner of their *Propagation* : For the discovery of this you see is by Accident, and not discernible by the naked *Eye*. 2. That the *Female Insects* of all kinds of *Flies* and *Butterflies* do probably put their *Spawns* near those Places where the *Erucas*, which are Hatcht of them, are to have their Food : So

The true Origin of *Caterpillars*, By Dr. Geo. Garden, n. 217. p. 54.

The General Insects Vid Inf. § LX.

So that they are to be searched for in such Places, by those who enquire into the Manner of their *Propagation*. 3. They seem to be fixed into the Cavities of the *Bearers* by a *Gluten*, so as that Rains do not wash them off. 4. The greatest *Frosts*, it seems, do no Hurt to the small *Eggs* of *Insects*; for I have seen the *Caterpillars Hatch*, after most Cold and *Frosty Winters*, of those *Eggs* which I have observed on the *Bearers* all the *Winter* over.

Observations
on a Glow-
Worm, by
Mr. J. Tem-
pler, n. 72.
p. 2177.

V. May 27. 1671. I put a *Glow Worm* into a small thin Box (such as *Pills* are sent in,) between 11 and 12 at Night, I saw her Shine, through the Box, very clearly on one side, the Box shut; putting *white Paper* into the Box, and the *Worm* into the *Paper*, it shined through the *Paper* and Box both.

28. In the Morning about 8 of the Clock, she seemed *Dead*, and holding her in a very dark place, I could perceive but very little Light, and that only when she was turned upon her Back, and by Consequence put into some little *voluntary Motion*. After Sun-set that Night, she walked briskly up and down in her Box, shining as clearly as the Night before; and that, when there was so much Day Light, that I could read without a Candle.

29. In the Morning she seemed dead again; at Night Recovered herself, and shined as well as ever, through the Box, and holding a large Candle in my Hand, the Light of it did not sensibly diminish that of the *Glow-Worm*.

30. 10. b. v. I set the Box with the *Worm* in it, about 4 Yards from me, in a Window, where I perceived it shine through the Box, for almost an Hour.

31. 4. b. m. I found it shining, and observed it in plain Day Light, for about half an Hour, and then wholly ceasing. At 5 in the Evening, the *Worm* shined pretty clear, in a very lightsome Room; at which time the Sun shined gloriously into the Room. Some time after she shined little, having contracted her Body into a bending Posture, the Light scarcely so big as a great Pins Head: But upon touching of her, she extended her self, walked in her Box, and at first extent shined as gloriously as ever.

N. B. I never saw her Shine without some sensible Motion, either in her Body or Legs, in her clearest Shining she extends her Body a third part beyond its usual Length; and, if my Senses fail me not, she emits a sensible Heat in her clear Shining.

Jun. 1. Upon several Tryals of Different Positions, I find her not to shine sometimes when in Motion: But I could never yet see her shine, when not in Motion of some part.

Jun. 8. Putting her into an *Urinal* of *white Glass*, at 9 a Clock at Night, she crawled nimbly into it, and extended her self beyond an ordinary Length, yet her Shining was not so clear, as in her Box when opened. Putting the *Urinal* into the *Water* for about half an Hour, it gave a very delightful *Irradiation* of the *Water*. When this Light seemed wholly *Extinct*, although it was in Motion, if I depressed the *Urinal* into the *Water*, till the Bottom almost touched the bottom of the *Bason*, I could (upon looking in at the top of the

the *Urinal*) see a very fair Light; but upon lifting the *Glass* out of the *Water*, I could discern very little *shining*. Then putting her into her Box, she did in about a Minutes time, for I tryed it twice over, by a Watch, almost 10 times increase her former *shining* in the *Urinal*.

14. The *Worm* seemed *Dead*, and being shut in a Box, would give no Light, though it was betwixt 9 and 12 a Clock at Night: But in the uncovered Box, or in the *Urinal*, she did *shine faintly*, and the *Light* was of a far different Colour from what it was formerly.

15. I touched her with a Needle gently, whereupon she stretched out one of her Legs, and by it, when I inclined the Position of the Box, she stayed her whole Body from falling. Before I prick'd her, she did give a little *shining* in her uncovered Box, but none through the *Urinal*: Only if you looked in at Top, a little *shining* was seen: Upon pricking her, I did not see her *shining* encreased.

16. I discerned a little *shining* only within her Box: Upon Pricking I could discern no Motion in her; but the Scale next her Tail, was sensibly more extended a $\frac{1}{4}$ of an Hour after I pricked her than before.

N.B. These last 3 Days, she lay continually upon her Back with her Legs contracted, except only the time mentioned June 15. of my pricking her. I am afraid to conclude her dead, June 16. having been informed by Mr. Th. Halleback of *Cald-Newton* near *Melton-Mawbury*, that he kept a *Glow-Worm* near 6 Months in his Parlour Window, which would sometimes seem dead for many Days together (if I mistake not, he said Weeks) and afterwards both Walk and Shine again.

VI. The *Cicindela Volans*, or *Flying-Glow-Worm*, is very rare in *England*, yet I have happened to catch of them twice at *Northaw* in *Hertfordshire*: First about *Midsummer* 1680, and for a Fortnight in *June* 1684. They flew about the Candle as soon as it grew dark; at both which times, the Weather was very Hot, and it may be it *shines* only at such Seasons, tho' the Animal be easie enough to be met withal Winged, when it shines not, and without Wings shining, which is the common *Glow-worm*.

The Description of it by *Aldrovandus* agrees very well with the Animal: But both *Monfret* and *Tho. Bartholin* are mistaken, in allowing the Male only to have Wings. The contrary was known to *Julius Scaliger*: And I once caught the Male and Female coupled, and could observe no difference between them, except in Size, (the Female being a little the larger) for they both *shined* alike. It's Light was very *Vivid*, so as to be seen plainly when a Candle was in the Room; but the *Vibrations* thereof were unequal, and the colour *Greenish*, like that of the *Creeping-Glow-Worm*. The *Luminous Part* was two small Specks on the underside of the Tail, at its End. The *shining* continued for a little while after the Tail was cut off, tho' it sensibly decayed, till at last it went quite out. Possibly, the use of this Light is, to be a *Lantern* to the *Insect* in catching its Prey; and to direct its course by, in the Night: Which is made probable, by the *Position* of it

E e e e

on

The Flying
Glow worm
By M. Rich:
Waller, n.
176, p. 841

Lib. 4. c. 8:
c. 1 f. p. 108.
De Luce 46
animalium.
Lib. 2. c. 12;

on the under Part of the *Tail*, so that by bending the same downward (as I always observed it to do) it gives a Light forward upon the Prey or Objects, the *Luminous Rays*, in the mean time, not being at all inconvenient to its Sight as they would have been, if this *Torch* had been carried before it. This Conjecture is also favoured by the placing of the *Eyes*, which are on the under Part of the *Head*, not on the *Top*. I observed also, that it could, and did, by some Contrivance, cover its Light, and make a kind of *Dark Lanthorn*.

Fig. 183. *Fig. 183.* Shews the *Insect* upon its Feet, with the Back upwards; where it appears to be of the *Beetle* kind. It is of a dark-brown Colour, unpolish'd: when the *Case-wings* are opened, it extends two very large *Membranous Wings*, fastened to the upper part of the *Thorax*. Its Head is covered, as it were, with a Shield, or Broad-brimm'd Hat.

Fig. 184. *Fig. 184.* Represents it laid on the Back, to shew the two *Eyes* under the broad Covering. They are Black, and very large, making almost the whole Head; there being little else to be seen. These are Moveable, so that the *Animal* can thrust them forward to the Edge of its Hat. From between these, are discovered 2 Hairy Feelers, or perhaps Brushes to cleanse the *Eyes*. Between these *Eyes* and the *Thorax* lies the Mouth. On the *Thorax* are 6 Legs, almost all of a length. The *Tail* is made of Seven Shelly Rings; at the last of which are Visible, the two *Shining Points*.

Fig. 185. *Fig. 185.* Shews the *Insect* on its Back, as it was seen through a *Microscope* when Dead; where *AA*. Represents the two long Horns, Feelers, or Brushes, consisting of ten Roundish Joints, besides the first, which is as long as two of the rest; they are all Hairy, and like those of some *Butter flies*; for all have them not. *BB*. The Broad Covering, or Hat, over the Head, which shewed of a Speckled Brown, and Yellowish Colour, like *Tortoise-Shell*. *CC*. The two *Eyes* composed of Innumerable small *Glassy Hemispheres* in Rows; as hath been observed by the ingenious Mr. *Hook*, in his *Micrography*, to be the make of *Insects Eyes*, so to supply the Defect of Motion in their *Eyes* by the Number of *Pupilla's*. I have seen these Spherical Bodies in the *Eyes* of some *Butter flies*, set in Circles not in Rows; with long Hairs growing out of each space, left by the Connexion of three *Hemispheres*. *DDDDDD*. The Legs of a Shelly make like *Lobsters*, and so Jointed. As well in this as other *Flies*, they are covered with many Stiff Hairs, tho' not so full as those of the *Blue-Fly*, Figured by Mr. *Hook*. The Mechanism of the Feet, as I take it, are much the same; only what is there called the *Pattens*, were here wanting (if not broken off, as I believe they were not,) and their use supplied by the *Gibbons* Part, Represented by *ddd*. The *Talons* *eeeeee* of the Feet were shining, and very Sharp Pointed. The Legs were of two long Joints, and the Feet of 4 more, besides that which was Armed with the *Talons*. These seemed to be Joynted one into Another, and were all thick beset with Hairs, or Bristles. *E*. The *Thorax* of but one Shell, of a Polish'd Copper Colour, stuck

stuck full of *Tapering Bristles*, a small dent being discernable in the Shell wherein each grew. F. the *Tail*, consisting of 7 Rings of the same brownish Colour; without Hairs except on their Edges, which were set with them like a thin Fringe, as the Tails of *Lobsters*, &c. are. These Rings were of an unequal shining Shell-Cover. ff. The Back or upper Part, of two or three Rings of the *Tail*, turned up to shew the Work of the Shell on that side. On the inside of the Last of these was the Light placed tho' there was now nothing to be seen, except that part being a little lighter colour'd than the rest of the *Tail*. G G G. the *Membranous Wings*, in every particular like those of the Blue-Fly, with Hairs upon the Veins, or Quilly parts. H H. the insides of the *Cafe wings*, which were Hairy, pointing all downward, the outside of these *Cases* is also very Bristly.

VII. In the *Harvest Time*, 1666. the Sickneſs raging then at *Cambridge*, at *Bassenburn* in *Cambridgshire* there were Millions of *Maggots* on the *Corn Lands*; and in their Barns too, the Floor would be cover'd with them that fell from the Carts. The *Maggots* were about half an Inch long, no thicker than a *Pigeons Feather*, of a White Colour, somewhat shaded with an *Isabella*, or faint Yellowish stripes, the length of the Worm; they had 14 Feet, after the manner of many *Caterpillars*, and I was almost Confident would have produced some sort of *Moth*. I took up about a Score of them, and put them into a Box: but they immediately offended me with an ungrateful and strong Stink, which yet is not usual to the *Caterpillars-kind*. After two Days, I rid my self of them, and only observed, that the *Excrements* which they voided, were little hard *Pellets* of pure white Flower, like that of Barley.

As odd Sort
of Maggots,
By Dr. M.
Lifter, n. 160
p. 595.

VIII. Some few Years since there was such a Swarm of a certain sort of *Insects* in *New England*, that for the space of 200 Miles they poysoned and destroyed all the *Trees* of the Country, there being found innumerable little Holes in the Ground, out of which those *Insects* broke forth in the form of *Maggots*, which turned into Flies that had a kind of *Tail*, or *Sting*, which they stuck into the Tree, and thereby Envenomed and Killed it.

Swarms of
Strange and
Mischivous
Insects in
New Eng-
land, By ---
n. 8. p. 137.

IX. The *Libella* is a Flying *Insect*, called in *France*, *Demoiselle*, from the Variety of its Colours, Transparency of Wings, and its stately Flight. They also call it *Pearle*, from the Figure of its Head, or rather from the roundness and Colour of its Eyes. It is divided from space to space into Rings, by means of which it composes *Angles* with its *Body*, whose Lines it can make longer or shorter as it finds occasion.

The Libella.
By M. Pou-
part, n. 265.
p. 673.

These different *Sections* serve to the Motion of this *Insect*, as we know the Tail doth in Birds, and as they are Lengthned or Contracted, they carry themselves according to their Various Inclinations, the Point or Center being fixed between their Wings. All Modern Naturalists know

the greater sort of *Libellæ* are Generated under *Water*, wrapt up in a *Membrane*, which at length dissolves and turns to nothing.

When the Young *Libella* is ready to quit its Case, it *Dilates* its *Belly*, that the *Water* may enter in at the *Anus* upon the *Intestines*, then it *Compresses* it self to *Circulate* the *Water*, which it *Expels*, and shoots out a great way. It receives more *Water* into its *Intestines*, and *Ejects* it after the same Manner. It continues this Action with great Force for some time, and makes the *Water Circulate* in the *Vessel*.

To satisfy my self that it took the *Water* in at the *Anus* and not at the Mouth, I put a *Libella* upon my Finger, which I held fast by the *Legs*, I dip it under *Water* with its Head downwards, the *Anus* being even with the *Water*, so that it might get into the *Intestines* which it cast out a good way, I drew my Finger a little further out, so that the *Water* could not enter at the *Anus*, and the Fly continued its Motion, but ejected no *Water*. My Opinion is, she does this in order to Cleanse her self from all *Excrements* in that Element, where she leaves her old Robes, to appear in a more Glorious and new Form in the open Air.

There are a great Number of small Vessels which closely unite the Body of the *Libella* to its Case: It is necessary that these be dry, that they may the sooner break when it makes its efforts to get out of its Case, which cannot come to pass as long as there is any *Aliment* in the *Intestine* to afford Nourishment to the Case, and its Strings. And perhaps this is the Reason, why no *Insects* will take any Food, when they are going to Change their Forms: And if they do not cleanse themselves, as the *Libella's* do, yet they stay a great while longer, before they Change, without any *Aliment*; the *Libella* is no longer than half a Day in quitting its Case, and taking its Flight.

To know the Cause of its exceeding Swift and Whirling Motion, we must cut the Skin of the *Libella*, which is very fine, all along the Back, and be sure to bear the Point of the Scizzars upwards, lest we cut the Interior Parts. We must also draw the Skin to the Right and Left Hand, and fix it with Pins upon a Table, that we may Discover the 16 *Muscles*, which lye between the *Wings* and the *Legs*, (8 on each side) of the thickness, length, colour, and almost Figure or Shape of a Grain of Barley, Contiguous to one another, and without Adherence. We may observe that each *Muscle* is composed of many *Fleahly Fibres*, which do not seem to be Joyned together, but Terminate Round at the ends of the *Muscle* where they compose a Common *Tendon*; so that one might discern any of these *Fibres* to be a small *Muscle*, of which the chief is Composed. The use of these *Muscles* seem to me very Particular: For the same *Muscles* which flutter the *Wings*, serve also to stir the *Legs*. The upper *Tendons* of the *Muscles* enter into the *Wings*, I believe the same which the *Fibres* Compose, and the lower enter a good way into the *Legs*; yet the contrary Motions of these *Organs* are not at all hindred, for as long as the *Wings* Play, the *Feet* lie still, and serve for a Prop to the *Muscles* which stir the *Wings*; and when the *Feet* are

in Action, the *Wings* are quiet, and in their Turn serve to support the *Tendons* which direct the Feet.

The Eyes are like two thick oblong *Pearls* which begin at the Fore-part of the *Head*, and end in the hinder Part; their outward *Membrane* is dry, thin, transparent, and incloses a small soft Ball, filled with a very black *Liquor*; two small Canals fill'd with Air, enter into each of these Eyes, and run along to the great *Channel*, also furnished with Air; which accompanies the Intestine from the Head to the Tail. This *Structure* made me think, that the *Libella* could derive the Air contain'd in these Canals into the Eyes, to give it a greater Convexity to behold Objects that are very near: And on the contrary, the Air is forced out of the Eyes again to flatten them, when they look at remote Objects. And my Conjecture is not altogether frivolous, for having blown into the thick Canals, which are about the middle of the Body, the Eyes became considerably tumified and by letting the Air return they became flat again. If we leave a *Libella* dead for some Days, the internal Parts will putrifie, and come to nothing: But these Canals will remain entire, and as solid and firm as they were before.

X. Whether there be any *Spontaneous*, or *Anomalous Generation* of *Animals*, as hath been the constant Opinion of *Naturalists* heretofore, I think there is good Reason to question. It seems to me at present most probable, Of spontaneous Generation, by Mr. Ray, p. 74. p. 2219. that there is no such thing, but that even all *Insects* are the natural Issue of Parents of the same Species with themselves.

Fr. Redi hath gone a good way in proving this; having cleared the Point concerning Generation *ex Materia Putrida*. But still there remain Gmer. digi^o infestis. two great Difficulties; the First is, to give an Account of the Production of *Insects*, bred in the *By-Fruits* and *Excrescences* of *Vegetables*, which the said Redi doubts not to ascribe to the Vegetative Soul of the Plant that yields those Excrescencies; but for this I refer you to Mr. Lister. The second is, to render an Account of *Insects* bred in the Bodies of other Animals.

XI. 1. M. Verney, a French Apothecary at Montpellier, having described The Grain of Kermes, its use, and the way formed out of it, by M. Verney, p. 362. the Grain of *Kermes* to be an *Excrescence* growing upon *Wood*, and often upon the Leaves of a *Shrub*, plentiful in *Languedock*, and gathered in the End of *May*, and the beginning of *June*, full of a red Juice; subjoyns two uses which that Grain hath, the one for Medicine, the other for dying of *Wool*. For the latter use, they take the Grain of *Kermes*, when ripe, and spread it upon *Linen*, and at first, whilst it abounds most in *Moisture*, 'tis turned twice or thrice a Day, to prevent its Heating; and when there appears red Powder amongst it, they separate it, passing it thro' a Searce; and then again they spread abroad the Grain upon the Linen, until there be perceiv'd the same Redness of the Powder; and at the End, this red Powder appears about, and on, the surface of the Grain, which is still to be passed through a Searce, all it render no more.

In the Beginning, when the small red Grains are seen to move, as they will do, they are sprinkled over with strong Vinegar, and rub'd between ones Hand. If this red Powder should be let alone, without pouring Vinegar, or some other acid Liquor upon it, out of every Grain there would be formed a little Fly, which would skip and fly up and down for a Day or two, and at last changing its Colour, fall down quite dead, deprived of all the Bitterness, the Grain, whence they are generated, had before.

The Grain being altogether emptied of its Pulp or red Powder, 'tis wash'd in Wine, and then expos'd to the Sun; being well dried, 'tis Rubb'd in a Sack to render it bright, and then 'tis put up in small Sacks, putting in the midst, according to the Quantity the Grain has afforded, 10 or 12 Pounds (for a Quintal) of the Dust, which is the red Powder, that came out of it. And accordingly, as the Grain affords more or less of the said Powder, Dyers buy more or less of it.

'Tis to be noted, that the first red Powder which appears, issues out of the Hole of the Grain, that is on the side, where the Grain adhered to the Plant, and that that, which about the end appears sticking on the Grain, hath been alive in the Husk, having pierced its Cover; tho' the Hole, whence it commonly issues, remains close, as to the Eye.

The Insect
Husks of the
Kermes kind,
by Dr. M.
Lifter n. 71.
p. 2165. n.
72. p. 2177.

2. Some Years ago, I gathered off our English Oak, round Worm Husks, very like Kermes Berries; and I have often observed on Plumb Trees, and Cherry-trees, also on the Vine, and Cherry-Laurel, certain Patellæ or flat Husks, containing Worms, which, (or at least the Husks) will strike a Carnation with Ly and Stand. In May 1671. I observed the same Patellæ, or Husks, indifferently on Vine-branches, Cherry-Laurel, Rose-Bushes, Plumb-Trees, and the Cherry-Tree. The Figure of the Husks is round, save where it cleaved to the Branch; for Bigness, somewhat more than half a Gray-Pea: These, I say, cleave to their Branches, as Patellæ do to Rocks; for Colour, they are of a very dark Chestnut, extremely smooth, and shining Membrane like. They adhere most commonly to the underside of a Branch, or Twig, and so are best secured against the Injuries of the Weather; as too much Sun and Rain. They are well fasten'd to the Branches single, and sometimes many in Company. They are seldom found without Vermin, as Pismires, &c. which I guess, pierce them, and prey upon them. If you cut off dexterously the top of the Husk with a Razor, you'll find sometimes 5 or more small white Maggots, of the Wasp, or Bee-kind, that is, sharp at both Ends. If when you have cleared the Husk, you rub the empty Membrane upon white Paper, it will freely and copiously tinge the Paper with a beautiful Purple, or Murrey.

n. 73. p. 2156
n. 76. p. 2294

Jan. 10. 1671. I found several of these Patellæ Kermiformes hatched in a Box, where I had purposely put them, they prove a sort of Bees, but certainly the least that ever I yet saw of that Tribe, as not much exceeding in their whole Bulk the half of a Pismire. They are very compact and thick for the Bigness, of a coal-black Colour. There is a remarkable Spot on their Backs, white, or straw-colour, large and round. The upper pair of their Wings are shaded, or dark spotted, the undermost Pair are clear. We may entitle them, according to our Custom, *Apiculæ Nigræ, macula super Humeros sub-*

vescent

vescente insignita, e patellis sive Favis membranaceis, veri Kermes, similibus. Junque isidem purpura tingentibus, Cerasi aut Rosæ aliarumve Arborum Virgis adjectis, exclusæ.

It is to be further observed,

1. That those that look the blackest, yield the deepest and best Purple.

2. That as the Bees come to Maturity, the Dye seems to be spent, and the Husks grow dry.

3. That the young ones make their Way out at several small Holes, that Hole in some of the Shop Kermes, being accidental only and ever on the bottom part cleaving to the Branch, and the Time of gathering them for Colour, is without Doubt before they are pierced; and whilst the Animal is yet in Vermiculo, and consequently the Husk entire.

We compared these Purple Kermes with the Scarlet Kermes or Grains of the Shops, and found them in every Point to agree, save in the Colour of their Juices; and particularly, (finding in some Parcels of the Shops many yet sticking to little Twigs of the Ilex) we confidently affirm, that those, as well as ours, are only contiguous to the Ilex Branches, and are not Excrecencies of the Tree, much less Fruit or Berries, by which abusive Names they have been too long known; but that they are the Artifice and sole Work of the Mother Bee, in order to the more convenient Hiving and Nourishment of her Young.

These things are also certain, viz.

1. That we have seen the very Gum of the Apricock and Cherry Laurel Trees transudated, at least standing in a Chrystal Drop upon some, though very rarely, of the Tops of these Kermes.

2. That they change Colour, from a yellow to a dark brown, and that they seem to be distended, and to wax greater, and from soft to become brittle.

3. That they are filled with a sort of Mites, concerning which I am pretty well assured by my own, and also by Dr. Johnson of Pomfret's more accurate Microscopical Observations.

4. That the Bee Grubs actually feed on Mites; there being no other Food for them.

5. That there are other Species of Bees or Wasps, besides those by me described, which are sometimes found to make these Mites their Food. Dr. Johnson having opened one Husk, with only one large Maggot in it.

6. That there are probably different sorts of Mites in these Husks making possibly different Species of Kermes; For some I have found to hold Carnation colour'd Mites enclosed in a fine white Cotton, the whole Husk starting from the Twig, shrivelling up and serving only for a Cap or Cover to that Company of Mites. Other Mites I have seen white, and which is most usual, the Husks continuing entire, and not coming away from the Twig; they adhere to, and but little Cotton at the bottom.

7. That the shrivell'd Cap, to be found upon the Mites inclosed in the Cotton, as also to the whole Husk it self, if taken early in April, while soft, will

will (dried in the Sun) shrink into the very Figure of *Cochineel*: Whence we guess, that *Cochineel* may be a sort of *Kermes*, taken thus early and sun-dried.

I conceive that the small *Scarlet-powder*, mentioned by Mr. *Verney*, is to be understood of those Mites, and that they are to be distinguished from the Bee Grubs, which are changed into the Skipping Fly, that is, the *Bee*, for Kind at least, here described by us.

Observations
on vegetable
Excrec-
encies and In-
sects genera-
ted in them,
By Dr. M.
Lifter, n. 75.
p. 2256.

XII. 1. The Account I have given of the *Purple Kermes*, both gives a clear Light to the Discovery of the Nature of the *Scarlet Kermes*, a Thing wholly unknown to the *Ancients*, and also is an evident instance, that some Things confidently believed Vegetable Excrecencies, are no such matter, but artificial Things, meerly contiguous to the Plant, and which have no other Relation to it, than the *Patella* Shell-Fish to the Rock it cleaves to.

2. Generally, Insects Eggs laid upon the Leaves of Plants, their respective Worms feeding on them, do not occasion or raise Excrecencies.

Thus, for Example, the Eggs of the common red *Butterfly*, laid upon the *Nettle*, are thereon hatched without Blistering the Plant into an Excrecence; and the stiff haired, or prickly *Caterpillars*, hatched from these Eggs, feed upon the Leaves without any ill Impression, Puncture, or Prejudice, save that they make clean Work, and eat all before them.

3. Some *Insect* Eggs laid upon the Leaves or other part of Plants, do as soon as hatched, pierce and enter within the Plant to feed. I had a convincing instance to the Truth of this Proposition.

May 22. 1671. When I observ'd on the Back or Underside of the Leaves of *Atriplex Olida*, certain small milk-white oblong Eggs; on some Leaves 4, on others fewer, or more. These Eggs were on some Plants yet unbatched, but on many of the same Plants I found the Egg-shells or Skins yet adhering to the Leaves, and the little Maggots already entered, thro' I know not what invisible Holes, within the 2 Membranes of the Leaf, and feeding on the inward pulp or substance of the Leaf; in other Leaves of that Plant I found those Maggots grown very great, and yet the two Membranes, that is, the uppermost and undermost Skin of the Leaf entire, but raised and hollow like a *Bladder*. Note, 1. That those Maggots were of a *Conick* shape. 2. That in *July* they shrunk into *Fly Chrysalis*, and accordingly came to Perfection; And to this unobvious Way of Feeding we think we may Refer all worm Eaten Fruits, Woods, &c.

4. Worms feeding within some of the Parts of some Plants, do cause Excrecencies: Thus the Heads or Seed Vessels of *Papaver*. *Spart. Sylv. Emat.* &c. are disfigured for having Worms in them, and grow thrice as big as the not seised ones. This is also plain in the Excrecencies of *Pseudo-Teucrium* and *Barbarea*.

5. The Substance or Fibrous Part of many vegetable Excrecencies seems not to be the Food of the Worms found in them; that is, the Worms in those vegetable Excrecencies which produce *Ichnoumons*, (to which kind of Insects we would limit this Proposition) do not seem to devour the Substance or Fibrous

Fibrous

Fibrous part of them, as other Worms eat the Kernels of *Nuts*, &c. but whatever their manner of *Feeding* is, (and we doubt not but they are nourish'd in and upon some part of them) the *Vegetable Excrecences* still mightily increase in Bulk, and rise as the Worms feed. And it is observable (to endeavour a Solution) that some of the *Ichneumons* delight to feed on a liquid Matter, as the Eggs of *Spiders*, and the *Juices*, if not Eggs, within the Bodies of *Caterpillars* and *Maggots*. Whence we conjecture, that those of the same Genus, to be found in *Vegetable Excrecences*, may in like manner suck in the Juices of the equivalent Parts of Vegetables. And this the dry and *spongy Texture* of some of those kind of Excrecences seem to evince. For if you cut in pieces a wild *Poppy Head*, for Example, (or the great and soft Balls of the Oak) you'll find in those *Partitions*, wherein these Worms are lodged, nothing but a pithy Substance, like that of young Elder; and if there chance to be any *Cells* yet unseised, which I have sometimes observed, the Seeds therein will be found yet entire and ripe; whence 'tis very probable that they feed upon, or suck in by little and little, the yet liquid *Pulp* of the tender Seeds, and leave the Substance, or fibrous Part, to be expanded into an *Excrecence*.

Vid. inf. §. XIV.

XIII. In some *Aleppo Galls*, which the Insects had not eat their Way out of, I found a sort of *Bee* resembling the small sort of our *wild Bees* which *Earth*, they have long Wings, a deep Belly, and on the Back, near the Commisure to the Body, it is of a *greenish black*, the rest *reddish*, near a *Cinnamon Colour*.

The Gall-Bee, by Mr. Ben. Allen, n. 245. p. 375.

These *Galls* are very gummy, and the Cavity round them was so extremely gummy, that not the least Room or Entrance of it appeared, tho' the *Bee* was beginning to make its way out. Some of the *Galls* had a *Stem* to them, and may give some Light to the Reason of Life, that the *Atmospherical Air* is not necessary to the Essence, before the Organs of the Body are employ'd; but that that is maintain'd by a subtler Air, that pervades more minute Pores, as it is conveyed to Fish through the Water.

I have also found in the grayer sort of *Gall*, not so rich in Gum, a small *Ichneumon* of a bright Green.

XIV. I. As I remember, Mr. Lister's Opinion is, that the *Mustæ Ichneumon* lay their Eggs in the Bodies of *Caterpillars*; which I look upon as very ingenious and true. These *Ichneumones* have all 4 *Wings*, *Antennæ* like *Bees*; their Body hanging to their Breast by a slender Ligament, as in Wasps; most, not all, had Stings, and are made of a *Maggot* that spins herself a *Theca* before she turns into a *Nympha*. There is great variety of them, some breed like *Bees* do, laying an *Egg*, which produceth a *Maggot*, which they feed till it comes to its full growth; others, as we guess, thrust their Eggs into plants, the Bodies of living *Caterpillars*, *Maggots*, &c. For, it is very surprising to observe, that a great *Caterpillar* instead of being changed into a *Butterfly*, according to the usual Course of *Nature*, should produce sometimes one, sometimes 2 or 3, and sometimes a whole *Swarm* of *Ichneumones*. I have observed this *anomalous Production* in a great many sorts of *Caterpillars*, both

Ichneumon Wasps, and the manner of laying their Eggs in the Bodies of *Caterpillars*, by Mr. Fran. Willoughby, n. 7. p. 2279

hairy and smooth in several sorts of *Maggots*, and which is most strange, in one *Water Insect*. When there come many of these *Ichneumon* *Maggots* out of the Body of the same *Caterpillar*, they weave all their *Theca's* together into one *Bunch*, which is sometimes round, with a Web about it, just like a Bag of Spider's Eggs. But none of them feed upon the Spider's Eggs; but it is the similitude of those *Theca's* conglobated together to the Eggs of Spiders, that hath occasioned this Conjecture.

One of the green *Caterpillars*, common in the *Heaths* in the North, went so far on to her natural Change, that she made herself up into a great brown *Theca*, almost of the shape of a Bottle, which was filled with a Swarm of *Ichneumones*; and I have observed in 1 or 2 other sorts, that from the very *Aurelia* it self hath come an *Ichneumon*; which is very odd, that the *Caterpillar*, stung and impregnated by the *Ichneumons*, should be yet so far unhurt and unconcerned, as to make herself a *Theca*, and to be turned into an *Aurelia*.

I have often seen a great *Ichneumon* dragging a *Caterpillar* in the Highway. This Year, 1671. Mr. *Wray*, in company with another ingenious Neighbour, observed one hailing a large green *Caterpillar*, much bigger than herself, which after she had drawn the length of a *Pearch*, she laid down, and then takes out a little *Pellet* of Earth, with which she had stopped the Mouth of a small Hole, like a *Worm-hole*, then she goes down into it, and staying a very little, comes up again, and draws the *ErUCA* down with her into the Hole, and there leaves her; and afterwards not only stops, but fills up the Hole, sometimes carrying in little Clods, and sometimes scraping Dust with her Feet, and throwing it backwards into the Hole, going down after it herself, to ram it close. Once or twice she flew up into a *Pine-tree*, which grew just over her Hole, perhaps to fetch Cement. When the Hole was full, and even with the superficies of the Ground about it, she draws 2 *Pine-tree Leaves*, and lays them near the Mouth of the Hole, and flies away. Not taking notice that she came any more in 3 or 4 Days, we digg'd for the *Caterpillar*, and found it pretty deep. I put it into a Box, expecting it would have produced an *Ichneumon*, but it dried away, and nothing came of it.

We lately observed a sort of *Ichneumons*, or rather *Vespa*, which prey upon several sorts of *Flies*; when they fly with them, they hold them by the Heads, and carry them under their Bellies. These make Holes a great depth in the Ground, in which they lay their Young, and feed 'em with the *Flies* they catch, creeping backwards into the Ground, and drawing the *Flies* after them. I suspect they may at first lay their Eggs in the very Body of a *Fly*; but one *Fly* being not enough to bring the young one to its full growth, they feed it with more. Their *Theca's* are at last all covered over with the *Wings*, *Legs*, and other Fragments of *Flies*.

2. This kind of Insect is one of the greatest Puzzles in Nature, there being few Excrescences of Plants, and very many Births of Insects, wherein these slender Wasps after divers strange ways are concerned.

'Tis true, the Swarms of these *Ichneumons*, coming out of the Sides of *Caterpillars*, do immediately make themselves up into Bunches, and each particular *Theca*, from the *Cabbage Caterpillar*, (for Example) is wrought about with

with yellow Silk, as those from the black and yellow *Jacobæa* Caterpillar with *White*; but as for *Web* to cover those Bunches of *Tbeca's*, I never observed it but in the green Caterpillars, so common in our *Lincolnshire Heaths*, which are fixed to Bents or other Plants. These in Truth never but deceived my Expectation, for I verily thought I had found, when I first observed them, a Caterpillar equivalent to the *Indian Silk worm*; but having cut them in two, and expected to have found a Caterpillar's *Cbrysalis* in the middle, there presented themselves a Swarm of *Ichneumons*. These are as large, many of them, as my *Thumb*; that is, at least 4 times bigger than the *Folliculus* or *Egg Bag* of any *English Spider* I ever saw yet. I have had them in several Boxes, some 8, some 10, some 12 days in *Vermiculo*, feeding upon the very Cakes of Spiders Eggs, before they wrought themselves *Tbeca's* for further Change; and they seldom exceeded the Number of 5 to one Cake of Eggs, &c. So that you may assure Mr. *Willoughby*, this is no Conjecture, but a real Observation.

Concerning the Name *Ichneumon*, I refer you to Mr. *Ray*, who is another *Her-^{n. 77 p. 205.}* *sychius*; and we have Observations enough to make us believe, that those very *Insects* we have treated of are, for kind, the *Ichneumones* of the Ancients.

XV. It hath been credibly reported, that Horse-hairs thrown into Wa-^{Hair worms;} ter will be animated; and yet I shall shew you by an unquestionable Ob-^{by Dr. M.} servation, that such things as are vulgarly thought animated Hairs, are very ^{Lifter, n. 83} *Insects*, nourished within the Bodies of other *Insects*, even as *Ichneumones* are, within the Bodies of *Caterpillars*. I find many Particulars collected by the Industry of *Aldrovandus*, concerning this *Insect*: But our own Observation is this,

April 2. 1672. There was thrown up out of the Ground of my Garden, a certain coal-black *Beetle* of a middle size, and flat shape, and which I have observed elsewhere common enough. I dissected some of them, and was surprized to find in their swollen Bellies of these *Hair Worms*, in some 3, in others but only one. These Particulars we carefully noted:

1. That upon the Incision, they crawl'd forth of themselves.
2. That putting them into Water, they lived in it many Days, and did seem to endeavour to escape by lifting up their Heads out of the Water, and fastening them to the Sides of the Vessels; very plainly drawing the rest of their Body forward.
3. That they cannot be said to be *Amphisbæna*, but do move forward only by the Head, which is fairly distinguishable from the Tail by a notable Blackness.
4. That the 3 I took out of the Body of one *Beetle*, were all of a dark Hair Colour with whitish Bellies, somewhat thicker than *Hogs Bristles*, but I took out of the Body of another *Beetle*, one that was much thicker than the rest, much lighter coloured, and by Measure just $5\frac{1}{2}$ Inches long, whereas all the rest did not exceed $3\frac{1}{2}$ Inches.

Some Observations about Bees, by Dr. George Garden, n. 175.p. 137.

XVI. M. *Leeuwenhoek*, in 1673. took notice of 5 little *Instruments*, which are on the Head of the Bee before: 4 whereof are two Pairs, the one being called by him *Scrapers*, the other *Arms*, the fifth he calls the *Wiper*, supposing that by it they wipe off the Honey from the Flowers. This last is truly the *Sucker* or *Proboscis*, being hollow, and made up of all circular Fibres, wherewith the Bees suck the Honey from the Flowers.

The Globulets which break forth from the Attire of Flowers, described by Dr. *Grew* and *Malpighius*, which are for the most part of an oval Figure, and of different Colours, (some white, some yellow, some red) seem to be Bags of Liquors, and are the Materials which the Bees carry in for their *Wax*, as is evident not only from the different Colours of the *Wax* upon their Legs, according to the different Colours of the Globulets of the respective Flowers we see them light upon; but for that also, if you take them gathering *Wax* from any particular Flower, and view a small Parcel of that *Wax* with a *Microscope*, you will find it to consist of the Globulets of the same Flower; tho' it is not so easie to discover what Liquor they make use of, to cause them to stick together.

On the inner side of the hinder Legs of Bees, on the Joint towards the Toe, next to that on which they carry the *Wax*, there are a great many Rows of yellow, sharp pointed, stiff Bristles, set all in Order like the Teeth of Combs for *Lint*, which I look upon as the Instruments wherewith they break these Globulets, and prepare their *Wax*.

The Generation of a sort of Bees in old Willows, by Sir Edm. King, n. 65.p. 299.

XVII. I. About the beginning of *May*, 1670. Sir *J. Bernhard* sent me a piece of old *Willow-Wood* out of *Northamptonshire*, in which were lodged many Insects curiously wrapt up in green Leaves, in several Channels or Burrows, each with 12, 14 or 16 Leaves round the Body, and several of them with as many little round bits of Leaves at each end, to stop them up close. These thus made up, are near an Inch long, or the best part of an Inch, put in one after another into a Bore made in the Wood, fit for their Reception. They are in the manner of Cartrages of Powder, wherewith Pistols are wont to be charged. In some part of those Burrows, they are placed so near one another as to touch; in others, at some considerable Distance. These Insects observe this Method in placing themselves, that sometimes they make a direct way into the length of the Wood, sometimes they bore out into the Side, and run another way; those Channels being not unlike the Burrows of *Rabbits*, all which they fill up with these round Appearances of wrapt Leaves, all regularly wrought. In which I find either something alive, or Appearances of something that hath died there, and is putrify'd: In some a great Number of Mites, of a dark Ash Colour, shaped not unlike common Mites; in others, I find seeming Excrements of some small Insect, with the decayed Parts of the Dead Insect; in others, white Maggots. Some of these Maggots I took out of their *Thuses*,
or

or Bag, and put them in warm Places in the Sun, and they thereupon grew something bigger, but changed not Shape nor Colour, but died. The rest I kept close in a Box till the 8th of *July*. Then I took one of them out of the Wood, and opened the Leaves, and felt something stir, hearing also an humming Noise like that of a Bee; and as soon as I had opened the *Theca*, a perfect Bee did fly out against my Window, as strongly as a common Bee out of a Hive, having much of the colour and bigness of those when they are New Flyers. The rest being disturbed, eat themselves out. They have all Stings like Bees; and I am of Opinion that they are common Bees.

2. I have had the good Luck to find a great many of these *Cartrages* in a rotten *Willow*; and, by the shape of the *Maggot*, was confident they would produce *Insects* of the *Bee Tribe*. Mr. *Snell*, an ingenious Gentleman, brought of them to the *Wells* at *Astrop*, and directing me to the Place where he got them, I there found great plenty in the Trunk of a great *Willow*: Beginning to unfold some of them, Mr. *Wray* immediately judged them to be made up of pieces of *Rose Leaves*; and called to Mind, that this very Spring Mr. *Fr. Gessop* brought him a *Rose Leaf*, out of which himself saw a *Bee* bite such a piece, and fly away with it in her Mouth. Whereupon, searching the *Rose Trees* thereabouts, we found a great many *Leaves* with such pieces bitten out of them, as these *Cartrages* are made up of. The *Cuniculi*, or *Holes*, never cross the Grain of the Wood, excepting where the *Bee* comes in, and where they open one into another. From the Place of Entrance, they are wrought both upwards and downwards; so that sometimes the *Bee Maggot* lies under her Food, and sometimes above it. One end of the *Cartrage*, viz. That which is next the entrance, is always a little *Concave*; the other end, which is farthest from the entrance, a little *Convex*, and is received into the *Concave* of the next beyond it. The sides of the *Cartrage* are made up of oblong pieces of *Leaves*, and pasted together, the ends of round ones; and where ever they do not lie close one to another, the intermediate space is filled up with a Multitude of these little round pieces, laid one upon another.

The *Cartrages* contain a *Pap*, or *Batter*, of the Consistence of a Gelly, or something thicker; of a middle Colour between *Syrup* of *Violets* and the *Conserve* of *Red Roses*; of an *Acid Taste*, and unpleasant *Smell*. In each of these, at the *Concave* end, there lies one *Bee Maggot*, which feeds upon the forementioned Matter, till it grows to its full bigness, and then makes and encloseth herself in a *Theca* or *Husk*, of a dark red Colour, and oval Figure; in which she is changed into a *Bee*. The remainder of her Food you may find dried into Powder at the *Convex* end, and her Excrements at the *Concave* without the *Theca*.

The *Bees* were of a shorter and thicker shape, than the common *Honey Bee*, more *Hairy*, &c. But the surest Mark to distinguish them is, that the *Forcipes* or *Teeth* of these are bigger, broader and stronger; in shape like those of a *Wasp* or *Hornet*; from which she also sufficiently differs, in having a *Tongue* like a *Bee*, which they want.

They

By Mr. Fr.
Willoughby
ib. p. 2100.

They made their way out along the Channel through all the intermediate *Cartrages*, and not through the solid Wood. Of the Corruption of the Matter within the Cases, when the *Bee Maggots*, or *Nymphae*, happen to miscarry, are bred, First, little *Hexapods*, which produce *Beetles*; Secondly, *Maggots*, which produce *Flies*; Thirdly, *Mites*, &c.

From what hath been observed concerning this Bee, and by a great many more parallel Instances, it appears that it is the *Bee Maggot*, and not the Old Bee, that covers the Cells before the Change: For here the old Bee, when she hath left Provision enough with an Egg, closes up the *Cartrage*, and hath no more to do; the *Maggot* a great while after making the *Theca*, which is Analogous to the Cover of the Cells.

By Dr. Lister, n. 160. p. 594.

3. I have observed that the Bees breeding in Cases of Leaves, are not very scrupulous in the choice of those Leaves, but will make use of *Exotick Plants*; such as *Blue Pipe* or *Syringe Tree*. Here is a very strange *Oeconomy* of Nature yet unsolved: The furthestmost Bee, says Mr. Willoughby, makes her way out along the Channel through all the intermediate *Cartrages*: And according as these Channels run upwards or downwards in the Body of the Tree, the *Maggot Bee* at the far or upper end of each Channel is first Laid, and it should seem both Hatched and Perfected first. But I take it otherwise, that that Bee which is nearest Day, although it be last laid, is yet the first hatched; and I ground my Conjecture upon this, that it is probable that the Eggs in the Mother are all fit for laying, or equally ripe and forward, as we say, at the time that the first of them was laid, but are not therefore all laid by the Dam, until she has provided them of Meat and a House, each separately, as is the Nature of Bees; and yet in Recompence, the warmth of her Body, or rather the daily encreasing Heat of the Summer-Season, to which the *Mother Bee* is continually exposed, (whilst the first laid Eggs are shelter'd in their deep Channels) hastens their Vitality so much, that they are hatched Worms, and begin to feed, before the first laid, and consequently are first perfected into Bees: But this is Conjecture only, and not Observation.

By Mr. Fr. Willoughby, n. 74 p. 222.

4. The *Cartrages* that I got at *Astrop*, in *August* 1670. do now in *July*, 1671. almost every Day afford me a Bee; and I can hear them gnawing out their way before I see them. So that there is nothing irregular in the way of breeding of these Bees: But the Contrivance of God and Nature in it is very admirable. Having shut their young Ones in those Cells with sufficient Provision, they all, as well the uppermost as lowermost, before Winter, come to full growth, or are turned into *Nympha's*; in which Condition they are designed to lie all Winter, as the most of *Insects* do. The next Summer, those must necessarily be first excited out of their *Torpor*, and changed into *Flyers*, by the external Heat and Air that lie next it. If any be laid so late, that they have not time enough to come to the State of *Nympha's* before Winter, they will most certainly die; and then it is no Loss nor Inconvenience tho' their Cells be perforated.

XVIII. M. Villermont has received from *America* a sort of *Hony Comb*, (of a different make from the *European*) which is composed of small *Bottles* or *Bladders* of *Wax*, of a brownish Colour, inclining to Black; being as big as *Olives*, and shap'd like the *Spanish Olives*. They hang together in Clusters, almost like a bunch of *Grapes*, and are so contrived, that each of them has an Aperture during the time of Work, but it is clos'd up as soon as the Vessel of *Wax* is fill'd with *Honey*; and then the *Bees* go to work with another Vessel.

Their Lodgings are ordinarily taken up in a *Hollow Tree*, or the Cavity of a *Rock*, by the *Sea-side*; these being the properest Places to secure them from such Animals as are greedy of their *Honey*, and therefore likely to molest them: And they have the more need of this Caution, because they are more liable to be disturbed than ordinary *Bees*, as having no Stings, and being capable of doing good, but no hurt to any thing, as the Party that lived at *Cayenne* very well knows. When the Combs are removed, they must be carried gently, and in the same Position they lay in, till you come to the Place where you design to take out the *Honey*.

The *Honey* it self is clear and liquid as *Rock Water*, and hardly to be distinguish'd from it by the sight. When you would take it out, you must pierce every *Bottle* a little more than $\frac{1}{4}$ from the *bottom*; for if you pierce it lower, you find a *bottom* or *Sediment*, whose thickness would hinder it from running; and as you prick every *Bottle*, you must have some Vessel ready to receive what comes from it. This Gentleman says, that he thinks the *Liquor* is one of the most agreeable Things in the World. If you drink Fasting the Quantity of a good Glass, or about half a Pint, it will give you 2 or 3 Stools in about 2 Hours time, according to the Temperament of the Party; but if you drink it at Meals, it does not purge at all.

XIX. On *Thursday, Mar. 9. 1670*. there was at the next House to mine (in *Herefordshire*) a *Swarm* of *Bees*. It was a very fair Day to entice them; but else we never have them till the middle of *May*. I had it from the Owner, one *Parry*, now in my Work. And I enquired of him, whether they did not all leave the *Hive* (as sometimes they do unseasonably) either for want of Food, or out of distaste? He told me, no, but there are as many left behind as came forth. But I (who have some time studied the Regimen of that little industrious wise Creature) do conceive, that Poverty drew them abroad to seek their Fortunes; the infinite Wisdom having imparted such a Providence to that little *Common Weal*, as to send part of their Company abroad to shift, before their whole Stock of Food shall be consumed to the Destruction of them all.

XX. A. The *Bee House*, lying on one side, with the Frame placed in it.
 B B B B B B B B. The Frame.
 C C C C. The Screw Pins that hold the Frame fast.
 D. The Square Hole at top open.

E. The

A strange
sort of Bees
in the West
Indies; By
M. Villermont
n. 172. p. 1010
Fig. 186.

An Early
Swarm of
Bees; By Mr.
Rich. Reed, n.
70, p. 2128

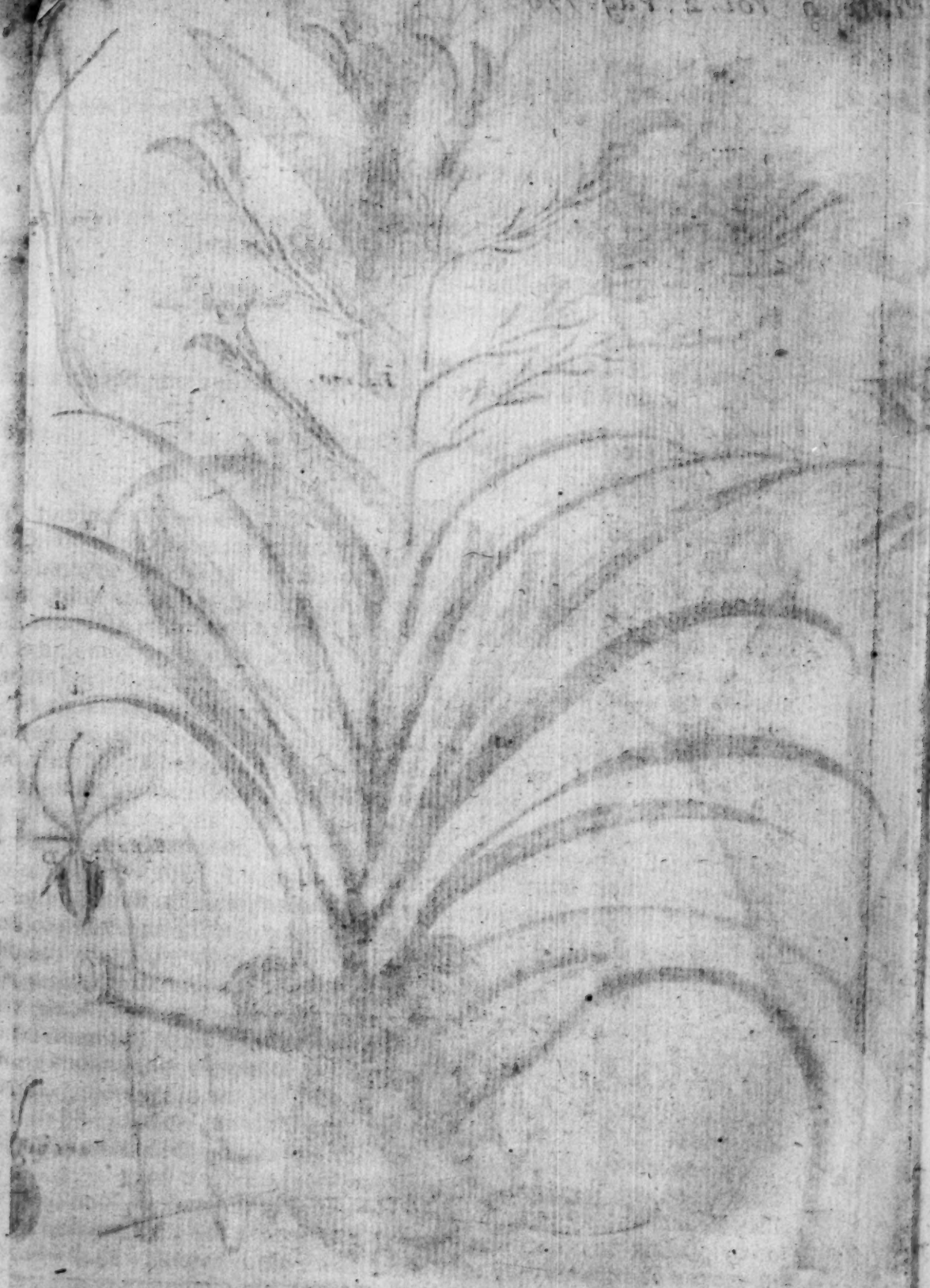
A Bee House
used in Scot-
land; By Mr.
H. Olden-
burg, n. 96,
p. 6076.

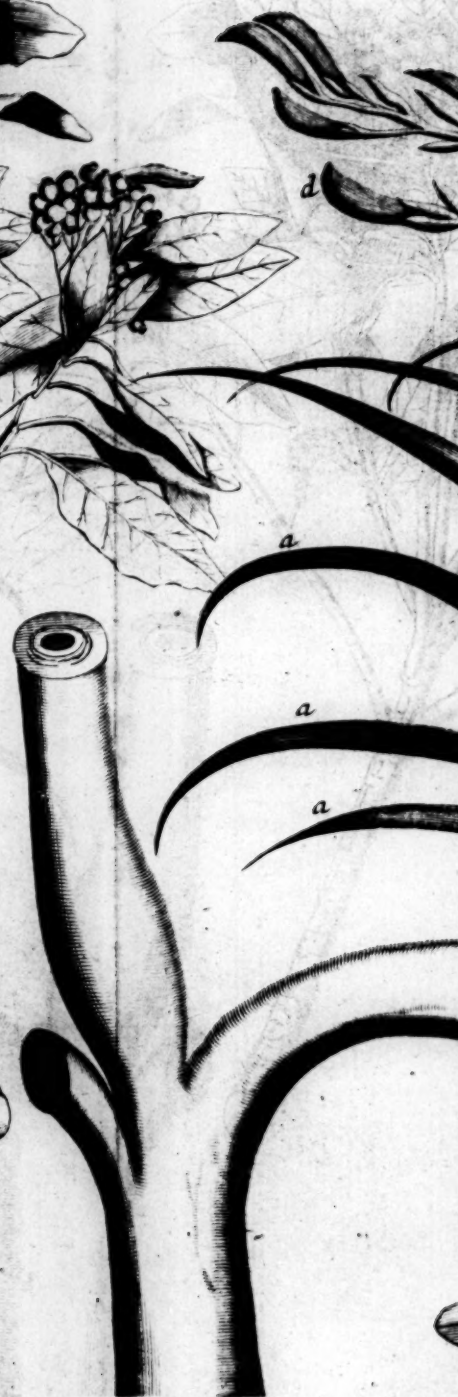
- Fig. 187. E. The Windows.
 F. The Door, for the Bees to go in and out.
 G. The Place by which the Knife enters to cut the *Honey Combs* asunder upon occasion.
 H H. The inward Crease at the *bottom*.
 Fig. 188. A. The *Bee-house* set upright:
 B. The square Hole, through which the Bees work downward.
 C. The Shutter that covers the Hole upon occasion.
 D. The Door for the Bees.
 E. A Sliding Shutter that covers the Door in *Winter*.
 F. The Window.
 G G. The Handles for lifting all.
 H H. The outward Crease at the top, for fastening one Bee-house over another.
 Fig. 189. A. The Frame for the Bees to fasten their Work upon.
 B B. The Screw Nails.

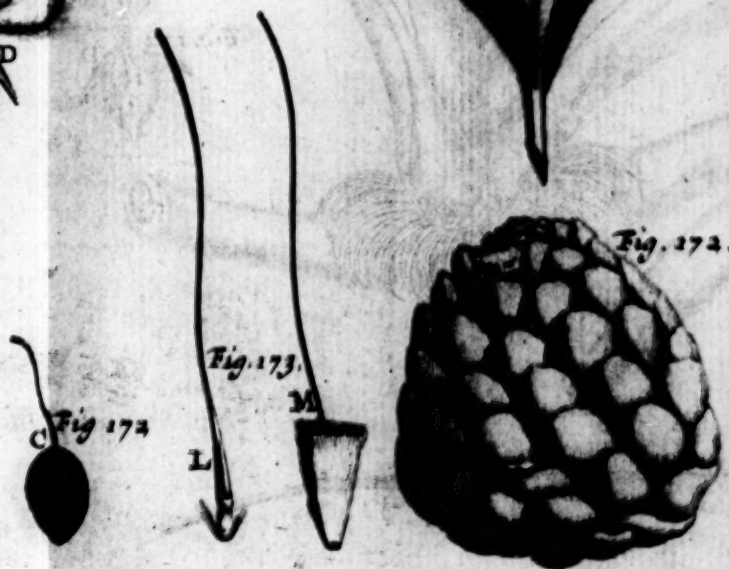
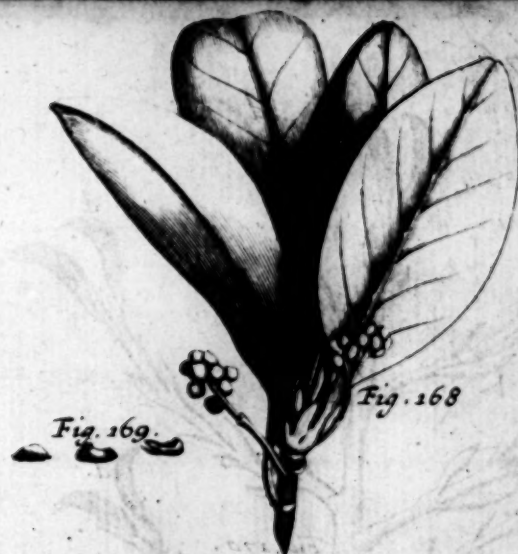
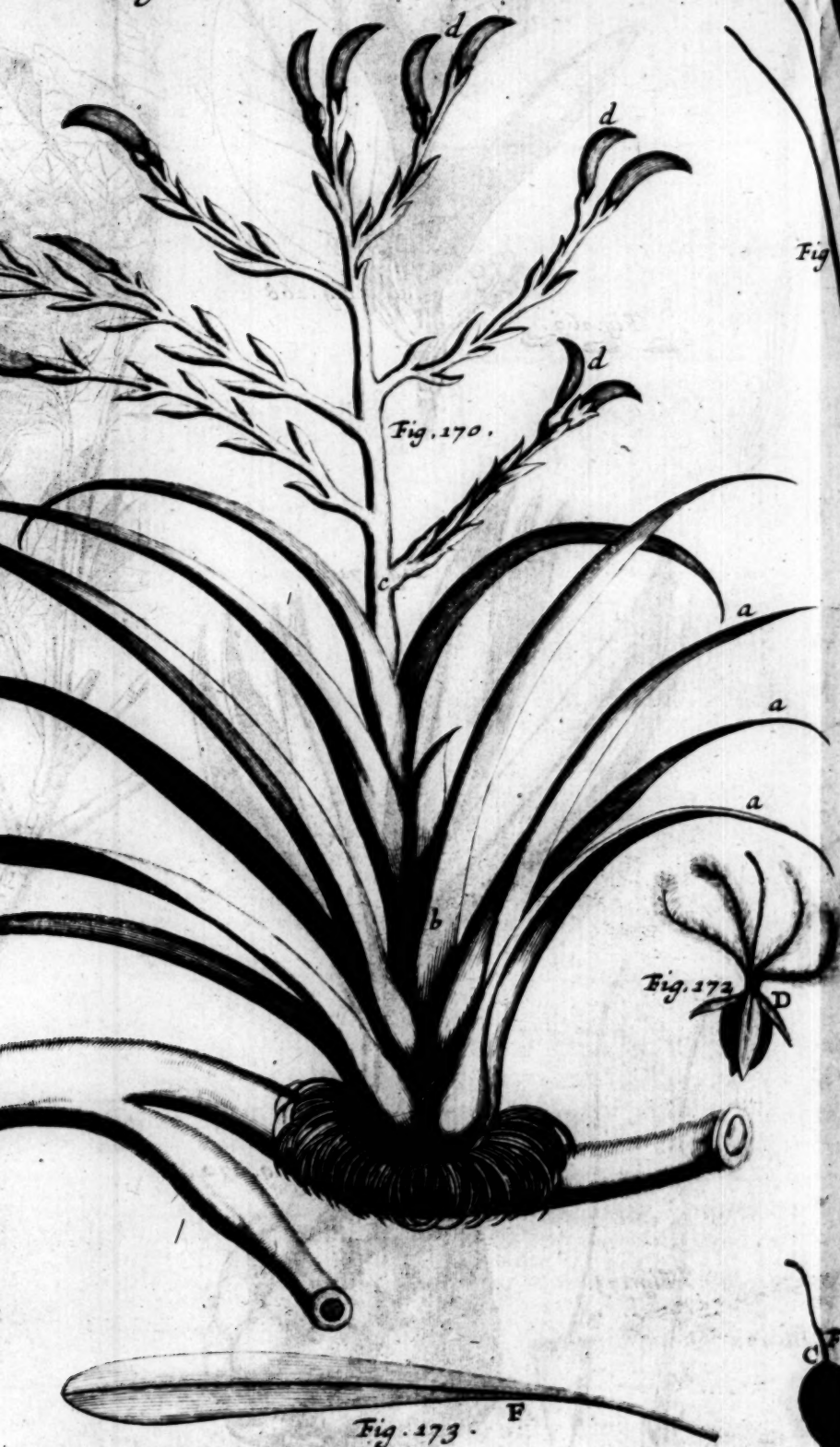
This Bee House, (which was sent by Sir *Will. Thomson*) is made of *Wainscot*, about 16 Inches in height, and 23 in breadth, between the opposite sides. It hath 8 sides, each almost 9 Inches in breadth. It is close covered at top with Boards, having a square Hole in the middle, 5 Inches long, and about 4 Inches broad, with a *Shutter* that slides to and fro in a Groove about half an Inch longer than the Hole. It hath 2 Windows, opposite to one another; and may have more of any Figure, with Panes of *Glass* and *Shutters*. The Door for the Bees is divided into 3 or 4 Holes, about half an Inch wide, and as high with a *Shutter* that slides in a Groove to cover them in *Winter*. It hath 2 *Iron Handles* with Joints, to be placed about the middle, if there be no Windows on the sides where they are; or above them, if there be. At the top it hath a Crease all round it, half an Inch in depth on the out side, and $1\frac{1}{2}$ Inch high; and another on the inside at the bottom, which serves to fix them when set upon one another. It hath also a Hole about 2 Inches in height, and as much in breadth on one side at bottom, by which the Knife is put in to cut the Bees Work, that passes through the Hole from one Bee House into another, as they work downward into the empty House, which hath a sliding Shutter to cover it. Within the Bee House there is a square Frame made of 4 Posts joined at top, at bottom, and in the middle, with 4 Sticks for the Bees to fasten their Work upon: Which tho' they may serve, yet it may be securer to have 2 more added in every one of their Places, crossing the Frame either from the middle of the opposite side Sticks, or from the Angles where the Posts are placed.

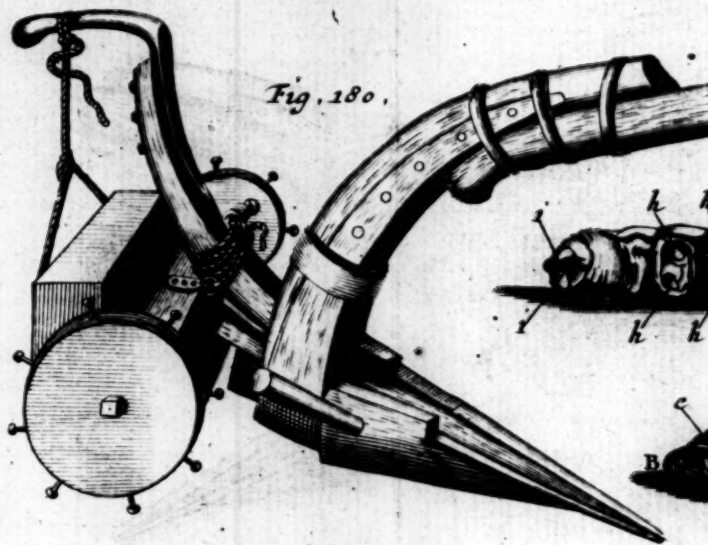
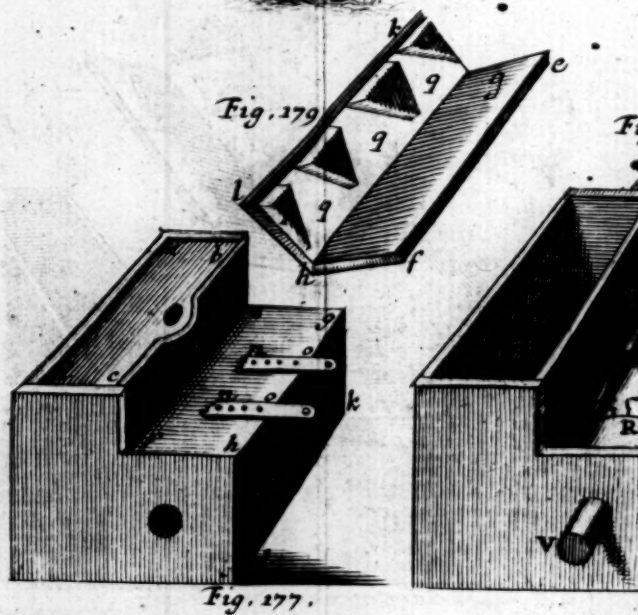
This manner of Bee House is useful for preventing the Swarming of Bees. For, when the Bee House wants room for the young Bees, 'tis known that they swarm and fly away to find a House for themselves: Which is prevented by placing an empty one made thus under the full one, having the Door at the top open, that they may work downwards into it. And when both are full, the Bees will all be in the lowest House; and then to get the *Honey* an

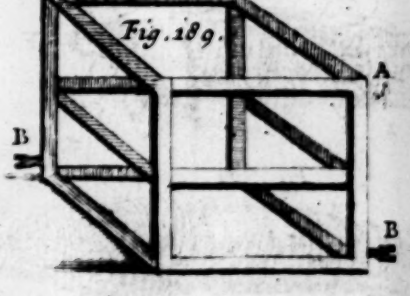
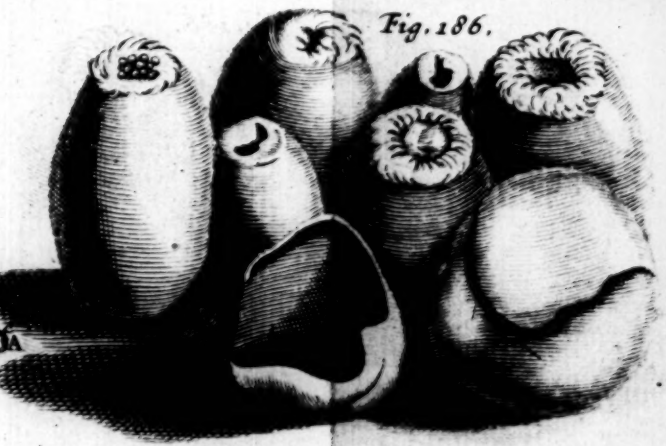
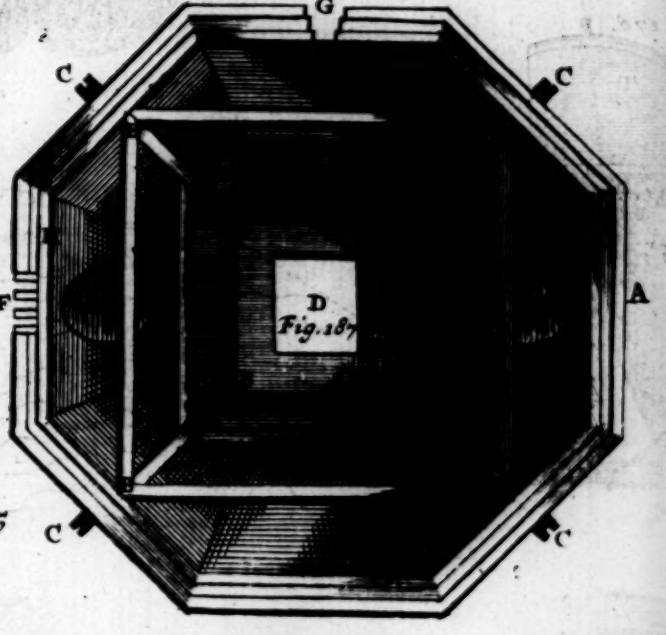
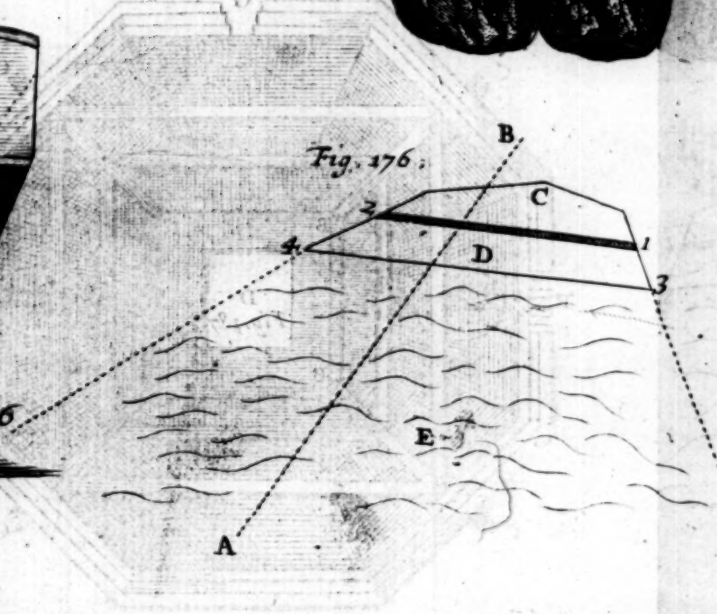
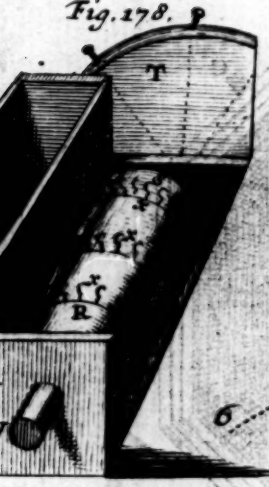
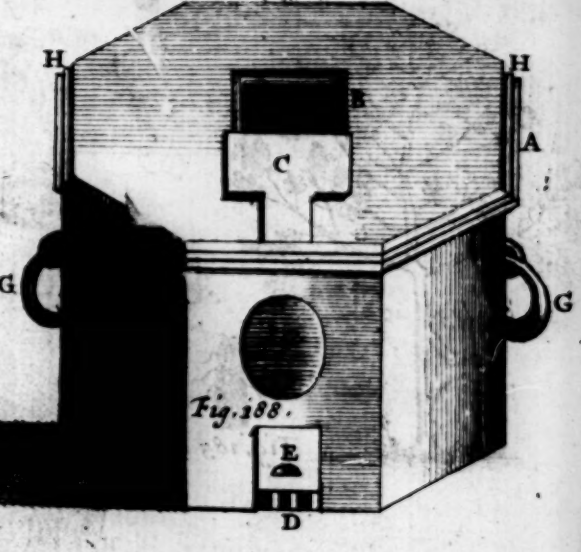
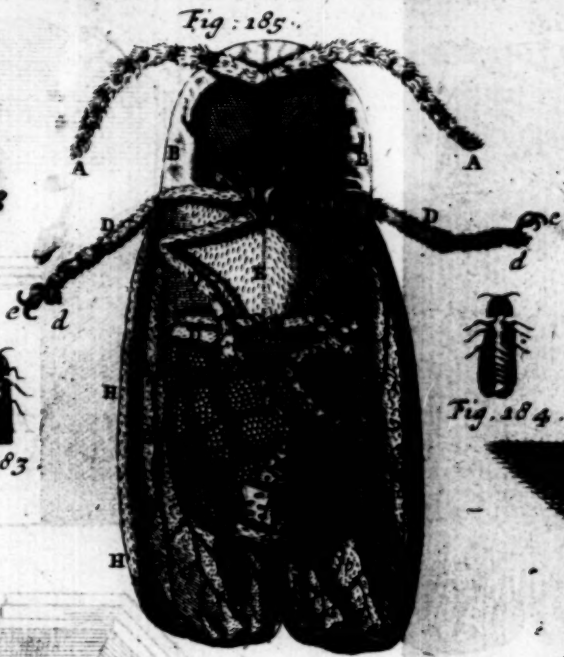
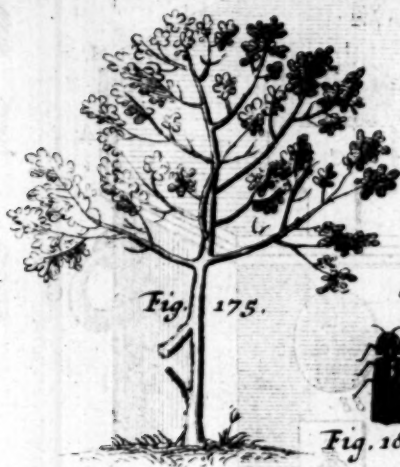
Vol. 2. Page 750

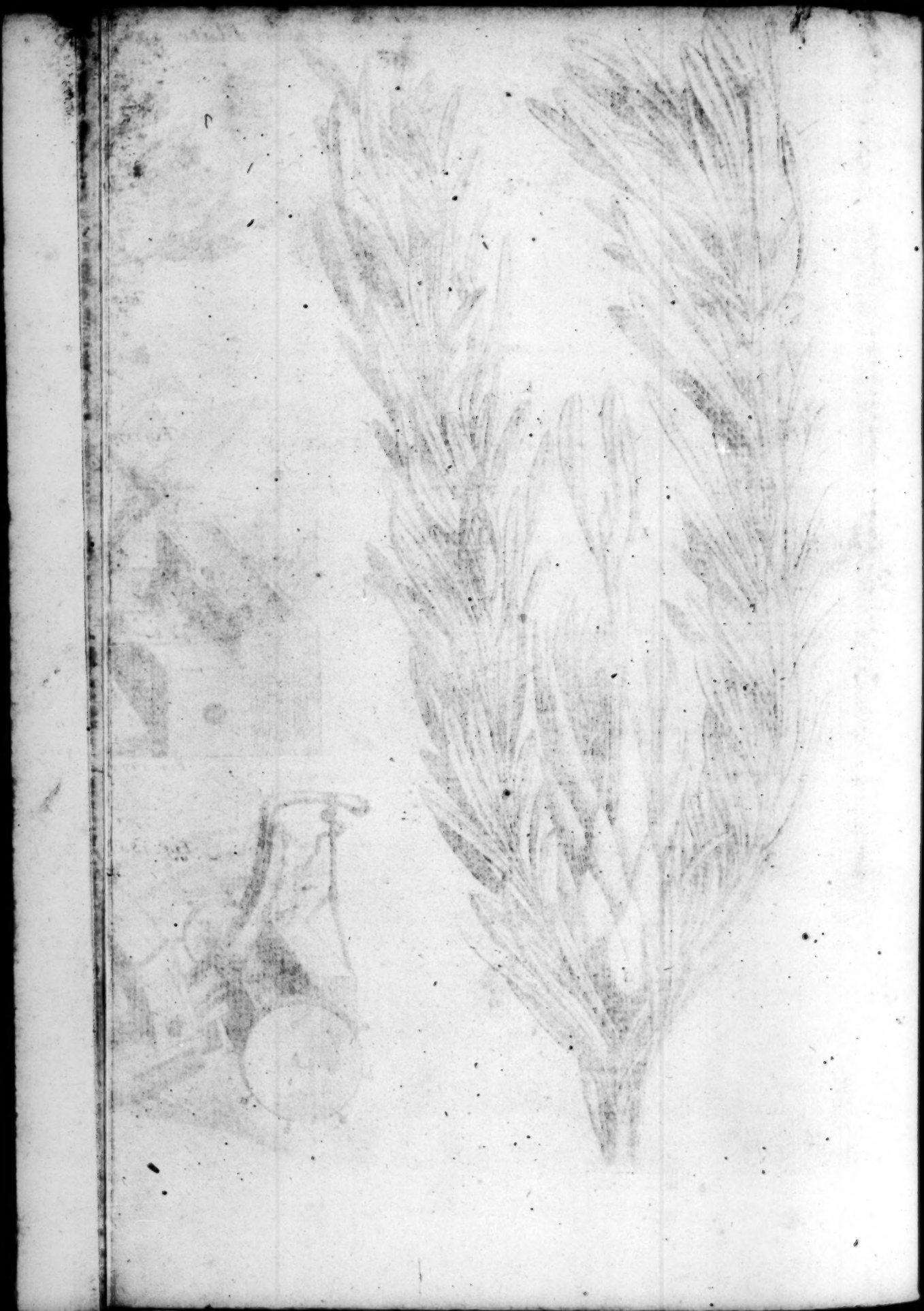












and *Wax*, without destroying or troubling the Bees, with a thin long Knife, broad at the end, and sharp on both sides; the Bees-work is to be cut as low as can be, and the uppermost Bee House to be lifted off by the Handles; and being reversed, the Screws are to be taken out, and then the Frame, with all the Bees-work upon it, will easily slip out; and so the empty Bee-House may be forthwith set under the other, if need be, and the uppermost having the square Hole above covered with the *Shutter*, some other Cover may be set over it, to keep the Bees from the injuries of the *Weather*. And if this Separation be made in the Spring, or Summer, the Bees will love their new House the better that it hath been used before.

XXI. I am inform'd that great Swarms of *Locusts* have lately appeared in *Wales*. They were first seen about the 20th of *October*, 1693. scattered about the Fields in *Marthery* Parish in *Pembrokeshire*; where they were generally taken notice of at first, because of the unseasonableness of the Time for *Grasshoppers*; but afterwards for that upon further Examination, they found them distinct from our *English Grasshoppers*, in bigness, colour, &c. I could not learn, that any of them have been seen flying in that Country: But from *North Wales* I am informed, that two vast Swarms of them had been seen in the Air not far from *Dol-gelben*, a Market Town of *Merionethshire*, and I guess, by the Date of my Friend's Letter, that it was near the same time that those others of *Pembrokeshire* had been taken notice of in the Fields.

Swarms of
Locusts in
Wales, By
Mr. Edm.
Floyd, n.
208, p. 45.

They are of the same Species with some *African Locusts* in my Custody in the *Museum Ashmolei*. for which we are obliged to Mr. J. Aubrey, who received them some Years since from *Tangier*. This *Pilgrim Locust* I call *Locusta Erratica*, *Alis lechthyocollæ adinstar Pellucidis, Reticulatis Maculis conspersis*. It is in length (from the Head to the tips of the Wings) 3 Inches and $\frac{1}{2}$, of a reddish Colour all over, except the Wings. As to the Head and *Capitulum*, it resembles the fourth Fig. of *Moufett*. The Eyes are Prominent and very large, somewhat of the form and bigness of *Gromwel Seeds*, of a reddish Colour elegantly streaked.

The *Antennæ* are about the bigness of a Hog's Bristle, and curiously *Geniculated*. The first pair of Legs are not quite an Inch long; the Second somewhat above that length; but the Third 2 Inches and $\frac{1}{2}$. These Hind Legs are very beautiful, for the Thighs are *Hexangular*, and elegantly sealed on the outside, with a black List extended length-ways through the midst of them. The Shanks are of a lively red Colour, adorned on the hinder part with 2 orders of small sharp Prickles, placed not opposite to each other, but alternately. The Wings are about 3 Inches long, resembling very much those of the larger *Libellæ*, or *Dragon-flies*, but all over garnished (the outer Wings at least) with *Reticulated black Spots*.

I see not much Reason to doubt but that these are the very same Species of *Locusts*, so famous in History for their wandring over, and depopulating whole Regions.

Plin. Lib. xi.
c. 29. *Jul.*
O. signatus
in Lib. Pro-
digiorum,
i. *Moufett*.

Green
Worms in
Wales; By
Mr. Edw.
Floyd, n.
103, p. 45

XXII. I find in a *MS. History of Pembrokeshire* (written about the Year 1603, by one Mr. Geo. Owen, a Gentleman of that Country, who seems to have been a Person of considerable Accuracy and Veracity) that about the beginning of *June*, 1601, a piece of Ground to the quantity of 200 *English Acres*, was covered suddenly (as if the same had fallen in a Shower out of the Air) with a kind of *Caterpillars* or *Green Worms*, having many Legs, and bare without Hair. They were found in such abundance, that a Man treading on the Ground should tread upon 20 or 30 of them: And in this sort they continued for the space of 3 Weeks or more, no Man knowing how they came, nor any of the like sort were ever seen in the Country before nor since; and being opened there was nothing found within them but Grass. The Place was on a Hill in the Parish of *Maen-Clochog* above *Hynnon Dbewi* or *Phynnon Dbewi*. They were found as it were with one accord to go one way, viz. up the Hill, and went over the Hill a quarter of a Mile and more: And as they went, they devoured and consumed the Grass, that the Ground appeared bare and white like *Tallow*. And after they had continued there 3 Weeks, there resorted thither an infinite Number of *Sea-Maws* and *Crows*, as if all of many Countries had been summoned thither, who in a few Days consumed them all. Also Swine fed upon these *Worms* eagerly, and waxed very fat.

Swarms of
Beetles in
Ireland; By
Dr. Tho.
Molyneux, n.
234, p. 711.

XXIII. According to the best Account I can get of the vast *Swarms* of *Insects* which of late Years have much infested this Kingdom of *Ireland*, I find that this Flying Army was first taken Notice of in the Year 1688. They appeared on the *South West Coast* of the County of *Gallway*, brought thither by a *South West Wind*, one of the common, I might almost say *Trade winds*, of this Country. From hence they made their way into the more Inland Parts, towards *Hedford*, a Place belonging to Sir George St. George, Bart. about 12 Miles North from the Town of *Gallway*. Here, and in the adjacent Country, Multitudes of them shewed themselves among the Trees and Hedges in the Day time, hanging by the Boughs Thousands together in Clusters, sticking to the Back one of another, as is the manner of Bees when they swarm. In this posture, or lying still and cover'd under the *Leaves* of the *Trees*, or clinging to the Branches, they continued quiet with little or no Motion during the heat of the Sun: But towards Evening or *Sunset*, they would all arise, disperse, and fly about, with a strange humming Noise, much like the beating of Drums at some distance; and in such vast incredible Numbers, that they darkned the Air for the space of two or three Miles square.

Those that were travelling on the Roads, or abroad in the Fields, found it very uneasy to make their way through them, they would so beat and knock themselves against their Faces in their Flight, and with such a Force, as to smart the place where they hit, and leave a slight Mark behind them.

A short while after their coming, they had so entirely eat up and destroy'd all the Leaves of the Trees for some Miles round about, that the whole Country, though it was in the middle of Summer, was left as bare and naked as if it had been in the depth of Winter: And the grinding of the Leaves in the Mouths of this vast Multitude altogether, made a sound very much resembling the sawing of *Timber*.

They came also into the Gardens, and destroy'd the *Buds, Blossoms,* and *Leaves* of all the *Fruit Trees*, that they were left perfectly naked; nay, many of them that were more delicate and tenderer than the rest, lost their Sap as well as Leaves, and quite withered away, so as they never recovered it again; particularly several Trees in the curious Plantation of one Mr. *Martin*.

Nay their Multitudes spread so exceedingly, that they got into the Houses, where Numbers of them crawling about, were very Irksome; and they would often drop on the Meat as it was dressing in the Kitchen; and frequently fall from the Ceiling of the Rooms into the Dishes as they stood on the Table while they eat; so extremely Offensive and Loathsom were they.

Their numerous creeping Spawn, which they had lodged under Ground next the upper Sod of the Earth, did yet more harm in that close Retirement, than all the Flying Swarms of their Parents had done abroad; for this young destructive Brood lying under Ground, fell a devouring the *Roots* of the Corn and Grass, and eating them up, ruined both the Support of *Man* and *Beast*. This Spawn, when first it gave sign of *Life*, appeared like a large *Maggot*, and by taking Food, and increasing every Day, became a bigger Worm, till at length it grew as big as a great *white Caterpillar*; from whence according to the usual *Transformation* natural to these smaller Animals, came forth this our *Flying Insect*.

The Rage of this Plague of *Vermis* was fortunately check'd several ways; High Winds, wet and misting Weather destroyed many Millions of them in one days time: Whence I gather, that though we have them in these *Northern* moist Climates, they are more Natural, and more peculiarly belonging to warm and dry Countries. Whenever these ill Constitutions of the Air prevailed, their Bodies were so enfeebled, they would let go their holds, and drop to the Ground from the Branches where they stuck, and so little a Fall as this, at that time, was of sufficient force quite to disable, and sometimes perfectly kill them. Nay, it was observable, that even when they were most Agile and Vigorous, a slight Blow or Offence would for some time hinder their Motion, if not deprive them of Life.

During these unfavourable Seasons of Weather, the Swine and Poultry of the Country watched under the Trees for their falling, and eat them up in abundance, being much pleased with the Food, and thriving well upon the Diet. Nay, I have been assured, that the poorer Sort of the *Native Irish* (the Country then labouring under a Scarcity of Provision) had a way of dressing them, and lived upon them as Food.

In a little time it was found that Smoak was very offensive to these Flies; and by burning Heath, Fern, and such like Weeds, in this or that Corner of

their Gardens or Orchards, which lay most convenient for the Wind to disperse it among the *Trees*, they would secure their Gardens, and prevent their Incursions; or if they had entered, drive them out again.

But towards the latter end of the Summer, they constantly retired of themselves; and so wholly disappeared, that in a few *Days* you should not see one of them left. Some think that they take their Flight like Swallows, and other Birds of Passage, as they are called, to a more distant *Country* and warmer Climate. But the true Reason of their disappearing, I take to be, that after their *Couition* is over, (for 'tis about this time they are seen to Couple by fastening to one another by their Tails) they retire under Ground, in order to lay their Spawn there, for a succeeding *Generation*; and likewise to compose and settle themselves to sleep for the rest of the ensuing Year, as several other Animals are known to do; for instance, *Snails* among *Insects*, the *Hedge-Hog* among the Beasts; and as I have good Reason to think, the *Ortygometa*, or *Raik*, among the Birds. And what further confirms me in this Opinion concerning these *Insects*, is, that I am certainly informed by several good Hands, that in the Spring time, by accidental Digging and Ploughing up the Ground, great Hollows or Nests of them are frequently discovered and broken up, where they find whole Bushels together in one heap, but in such a quiet Condition, they seem to have but little *Life* and *Motion*; for they do not stir unless you touch or disturb them, and then move but little and feebly, as if they had been asleep, and were awaken'd out of it. These large Caverns, to which they retire, are often met with under a firm, solid Surface of Earth, that has not been stirred or ploughed in many Years before; and no manifest Passage can be discovered how they got there.

In the Summer (1695 or 96) all along the *South West* Coast of the County of *Galloway*, for some Miles together, there were found Dead on the Shoar such infinite Multitudes of this *Vermine*, and in such vast Heaps, that by a moderate Estimate, one computed there could not be less than 40 or 50 Horse Loads in all. These, as I take it, were a *New Colony* or *Supernumerary Swarm*, from the same place whence the first Stock came to us, in 1688. driven by the Wind to Sea from their Native Land, which I conclude to be *Normandy* or *Brittany* in *France*, it being a Country much infested with this *Insect*, and that lies very open and exposed to all these Parts of *Ireland*, and from whence *England* heretofore has been pester'd in the same manner with Swarms of this *Vermin*. But these meeting, by good Fortune, with a contrary Wind before they could reach Land, their Progress was stop'd, and tired with their Voyage, they were all driven into the Sea, which by the Motion of its Waves and Tides cast their floating Bodies in heaps upon the Shore. And this was a most lucky Accident; for had this second Supply arrived, they would have exceedingly increased the Numbers of those which are already very troublesome to us.

It is observed that they seldom keep above a Year together in a Place; and their compute their usual Stages, or March, to be about 6 Miles in a Year. Hytherto they have directed their Progress *Westerly*; following the Course of that Wind which blows most commonly in this Country.

And

And this last Year, 1697. they reached as far as the *Shannon*, and some of the scattered loose Parties crost the River, and got into the Province of *Leinster*; but they were met there by a stronger Army of *Jack Daws*, which devour'd great Numbers of them. They begin to be apprehensive of them in the *Queen's County*, but they hope to divert their Passage thither by firing the *Heath* upon the Mountains between them and the *King's County*.

Where-ever the *Country* has been infested with this *Vermin*, by one consent, though erroneously, they have given them the Name of *Locusts*. But the true *Locust*, much resembling in shape a common *Grasshopper*, tho' larger, is quite a different sort of *Insect* from this, which belongs to that *Tribe*, call'd by the *Naturalists* *Κολοβίπτερος*, or *Vagini pennis*, the *Scarabeus* or *Beetle-kind*, that has strong thick *Cases* to defend and cover their tender thin *Wings*, that lie out of sight, and next the *Body*. And this Species is certainly that particular *Beetle*, call'd by *Aristotle* in his *Hist. of Animals* *Μελανίδης*, from its devouring the *Blossoms* of *Apple-trees*; and is the *Scarabeus Arboreus* of *Mou-*
fet and *Charleton*; called by the *English*, *Dorrs*, or *Hedge Chafers*. They are
 much of the bigness of the common black *Beetle*, but of a brownish Colour, something like that of *Cinnamon*; they are thickly bespersioned with a fine, short, downy Hair, that shews as if they were powder'd all over with a fine sort of *Dust*; the *Cases* of their *Wings* do not entirely cover all the Back, for their long picked *Tails*, where lie the *Organs* for *Generation*, reach a good way beyond them; and the *Indentures* or *Joints* of each side their *Belly*, appear much whiter than the rest. They are exactly figured by *Dr. Lister*, *Scarab. Tab. Mut.*

I am fully convinced that this *Insect* is the self same to which the *Septuagint*, and the vulgar *Latin Translation* retaining the *Greek Word*, give the Name *Βεζζες*, or *Bruchus*, derived from *Βεζζω* *Frendo vel strideo*, intimating the remarkable *Noise* it makes both in its eating and flying. It is often mentioned in *Holy Scripture*, *Levit. 11. 22.* *Joel 1. 4.* and *2. 25.* *Nabum 3. 16, 17.* But I find our *English Version* almost constantly translates this Word *Βεζζες*, tho' improperly, as I think, *Cancer-Worm*; since this denotes only a *Reptile*, or *creeping Vermin*, whereas that Word imports certainly a flying *Insect*; for the *Βεζζες*, *Nabum 3. 16, 17.* is expressly said to fly, and have *Wings*; and its *Nature* and *Properties* are most truly and particularly described in these Words, *It spoileth and flyeth away, they camp in Hedges in the Day, and when the Sun ariseth they flee away, and their Place is not known where they are:* That is, they then retire again to the *Hedges* and *Trees*, where they lie quiet and concealed till the *Sun* sets again.

I find indeed the Word *Βεζζες*, better translated *Locust* or *Beetle*, in that odd Clause of the *Jewish Law*, *Lev. 11. 22.* where *Moses* permits the *Israelites* to eat the *Locust* after his kind, and the *Bald-Locust* after his kind, and the *Beetle* after his kind, and the *Grasshopper* after his kind. I must confess, it long seemed to me very unaccountable, that here among the pure wholesome *Creatures*, proper for human *Nourishment*, *Beetles*, and those other nasty, dry, and unpromising *Vermin*, should be thought fit to be reckoned up as clean and proper for the Food of a Man: But since I have had some little Experience

rience of what has happened among our selves, I cannot but admire the sagacious Prudence of that Divine *Law-giver*. 'Tis certain *Palestine, Arabia, Egypt*, and the other Neighbouring Countries about them, were all extremely subject to be infested with these sorts of pernicious *Vermin*, and therefore *Moses* foreseeing the great *Dearth* and *Scarcity* that they might one day bring upon his People, gives them here a permissive *Precept*, or a sort of *Hint* what they should do, when the *Corn, Grass, Olive-trees, Fruit-trees, Vines*, and other *Provisions* were destroyed by the *Locust* and *Beetles*, swarming in the Land; why then, for want of other *Nourishment*, and rather than starve, he tells them, they might eat and live upon the filthy Destroyers themselves, and yet be clean. And thus we see the native *Irish* were Authors of a practical Commentary on this Part of the *Levitical Law*, and by Matter of Fact have explained what was the true Sense and Meaning of this otherwise so dark and abstruse a Text. It is also more than probable that this same destructive *Beetle* we are speaking of, was that very kind of *Scarabeus*, the idolatrous *Egyptians* of old had in such high Veneration, as to pay divine Worship to it, and so frequently grave its Image upon their *Agulios* and *Obelisks*, as we see at this Day. For nothing can be supposed more natural, than to imagine a Nation addicted to *Polytheism*, as the *Egyptians* were, in a Country frequently suffering great Mischief and Scarcity from *Swarms* of devouring *Insects*, should, from a strong Sense and Fear of Evil to come, (the common Principle of Superstition and Idolatry) give sacred Worship to the visible Authors of these their Sufferings, in hopes to render them more propitious for the future. Thus 'tis allowed of all Hands, that the same People adored as Gods the ravenous *Crocodiles* of their River *Nile*; and thus the *Romans*, tho more polite and civilized in their Idolatry, *Febrem ad minus nocendam venerabantur, eamque variis Templis exstructis colebant*; says *Valerius Maximus*, L. 2. c. 5.

The Vasa
testicularia
of a Beetle,
by Dr.
Stummer
dam, n. 94 p
6041, 6042.

XXIV. *Scarabæi Nasi cornis Genitalia*, quoad Vasa Testicularia, ad amissum cum Humanis convenire Testiculis, atque ex unico tantum Funiculo, longo, cavo, innumerabiliter flexo, atque (quod nondum in Homine mihi visum) Principio seu Apice Cæco, constare, non sine aliquo stupore lustravi. Non alienum itaque fore duxi eorum Delineationem Cl. tuæ transmittere; in qua imprimis exhibentur non modo Testiculi ex unico Funiculo duos pedes & sex Pollices longo. sed & Vasa Deferentia, semen copiosum ac Album, quando læduntur, stillantia; necnon Vesiculæ seu potius Glandulæ seminales sex, admodum elegantes; Glandularumque Seminalium ductus protensi, materiam seminalem subflavam (ut in hominibus ac Brutis quoque observantur) continentes.

A flying
Hart, by
n. 127. p. 652.

XXV. I here send you the Figure of a large *Flying Beetle*, of a dark shining Brown, with a huge pair of Horns, in proportion to the Body, shaped and branched exactly like a *Stag's* or *Harts*, from which last it hath its Denomination; our People in *Virginia* and *New-England* calling it a flying *Hart*. It flies high and swift, and rests most commonly upon Branches

or

or Trunks of standing Trees, where, as soon as it has taken up its Station, it begins with a shrill chirping Voice, which it raises by little and little, till it makes the whole Woods ring again, and then lessens gradually, till it ceaseth with a kind of silent Murmur, as if the little Creature had rung it self asleep; then it flies to some other Place, and begins the same Tune again.

The Horns are of a shining hard Substance, and the Tips of them touch the same Plane with the Belly.

XXVI. There is a *Cimex* of the largest Size, of a red Colour, spotted black, and which is to be found very frequently and plentifully, at least in its Season, upon *Henbane*: I therefore in my private Notes, intitle it *Cimex Ruber*, *Maculis nigris distinctis*, *super Folia Hyoscyami frequens*. This Insect in all probability doth feed upon this Plant, (on which only we have yet observed it) if not upon the Leaves, by striking its Trunk: the Note of Distinction of this Kind of Insect from the rest of the Beetle kinds) into them, and sucking thence much of its Substance, like as other sorts of *Cimices* will upon the Body of Man, &c. yet upon the unctuous and greasy Matter, with which the Leaves seem, to the Touch, to abound. It is farther observable, that that horrid and strong Smell, with which the Leaves of this Plant do affect our Nostrils, is very much qualified in this Insect, and in some Measure aromack and agreeable; and therefore we may expect, that that dreadful *Narcosis*, so eminent in this Plant, may likewise be usefully tempered in this Insect.

A Muskcentred Insect, feeding upon Herbane, by Dr. M. Lister, n. 72. p. 2. 76.

About the latter end of May, and sooner, you may find adhering to the upper Side of the Leaves of this Plant, certain Oblong, Orange coloured Eggs, which are the Eggs of this Insect. These Eggs yet in the Belly of the Females, are white, and are so sometime after they are laid: But as the Young ones grow near the Time of their being hatched, they acquire a deeper Colour, and are hatched *Cimices*, and not in the Disguise of Worms. If the riper Eggs be crushed upon white Paper, they stain it of themselves, without any addition of Salt, with as lively a Vermillion, or *Coleur de Feu*, as any thing I know in Nature; *Cochineel* scarce excepted, when assisted with Oil of *Vitriol*.

XXVII. 1. I have seen two sorts of Insects which smell of Musk. The one is like the common *Capricornus*, or *Goat Chaffer*, which is mentioned by all Naturalists that write of Insects, and which smells so strong of that Perfume, that you may scent it at a good Distance, as it flies by, or sits near you. The other is a small sort of Bee, which in the South and East Parts of England, is frequently to be met withal in Gardens among Flowers in the Spring-time.

Other Muskcentred Insects, by Mr. J. Ray, n. 74. p. 22. 0.

2. The two Insects mentioned by Mr. Ray, smell of Musk to an high Degree. The small Bees are very frequent in the Woods in *Lincolnshire*, and about the latter end of April are to be found in Pastures and Meadow, upon the early blown Flowers of a sort of *Ranunculus*, but it is something improper

By Dr. M. Lister, n. 76. p. 22. 0.

proper to say *Bees* feed on *Flowers*: And likewise the same *Bees* are no less frequent on the *Flowers* of *Dens Leonis*, &c.

The *Sweet Beetle* is a very large *Insect*, and well known about *Cambridge*. All the *Trials* I have made to preserve them with their *Smell*, have proved ineffectual: For both *Sorts* of these *Insects* will of themselves, in a very few *Weeks*, become almost scentless.

To these, I shall add another sweet-smelling *Insect*, which is a *Hexapode Worm*, feeding on *Gallium Luteum*.

n. 77. p. 3003.

Mr. *Willoughby* informs me, that he hath found the *Goat Chafer*, or *Sweet Beetle*, out of Season as to that *Smell*. Perhaps it might be at the time of the *Coit*: Forasmuch as at that time, when I took them highly perfumed, I had observed the *Female* full of *Eggs*.

The *Cochi-
neel Fly*, by
n. 40. p. 796.

XXVIII. 1. It is generally believed, that the *Cochineel* comes out of a *Fruit* called the *Prickle Pear*, bearing a *Leaf* of a slimy Nature, and a *Fruit* blood red, and full of *Seeds*, which give a *Dye* almost like to *Brasiletto Wood*, that will perish in a few *Days* by the *Fire*; but the *Insect* ingendred of this *Fruit* or *Leaves*, gives a permanent *Tincture*, as is generally known.

There grows a *Berry* (by report) both in *Bermudas* and *New England*, called the *Summer-Island Reed Weed*; which *Berry* is as red as the *Prickle Pear*, giving much the like *Tincture*; out of which *Berry* come out first *Worms*, which afterwards turn into *Flies*, somewhat bigger than the *Cochineel Fly*, feeding on the same *Berry*; in which we read there hath been found a *Colour*, no whit inferior to that of the *Cochineel Fly*; and as to *Medicinal Vertue*, much exceeding it.

'Tis also probable that *Insects* may be engendred out of other *Vegetables*; either *Herbs*, *Berries*, and other *Fruit* and *Woods*, giving the *Tincture* of its *Original*, which will hold in *Grain*.

To generate
other *Flies*,
for like use.

To breed *Insects* out of *Herbs*, dry them, for they yield the best *Tincture*, otherwise stamp them, and let them dry, till they will suffer no more *Juice* to run from them, (do this in the *Sun*, or in a proportionable *Heat*;) or if dried, infuse them with *Water*, in a *Heat* for 24 *Hours*, then vapour away the *Water*, till the *Dissolution* be as thick as a *Syrup* (but for this use strain them not from their *Feces*) take this *Mass* and put it into an earthen or wooden *Vessel*, covered with some *Straw*, or something else of that Nature, that it lie not too close, and so proportion the quantity to the *Vessel*, that the *Air* may come about, and into the *Mass*, yet not too much. Then set this *Vessel* in a *Ditch* or *Pit* made in the *Earth*, in a shady *Place*, and put about it some wet *Leaves*, or some such putrifying *Rubbish*, and over it a *Board*, and on that some *Straw*, or the like, and it will produce first a shelly, husky *Worm*, and then a *Fly* of the *Tincture* of *Concrete*, but durable, and somewhat more advanced.

And as for *Berries*, stamp and boil them, evaporating them to the *Consistence* of a *Rob*, and then use them as the former.

Lastly,

Lastly, for *Woods*, infuse them in Water, being first pulveriz'd, and boil out their *Tincture*, and then evaporate the Water to such a Thickness, as the other, and handle them in the like way.

The *Flies* will play about the Side of the *Vessel*, and the Surface of the *Matter*; which taken, are to be killed in a warm Pan or Stove, and so dried and kept.

2. An old *Spaniard* at *Jamaica*, who lived many Years in that Part of By n. 193. p. 509 the *West Indies* where great Quantities of *Cochineel* is made, affirms, that the *Insect*, whereof it is made, is the very same which we call the *Lady bird*, or *Cow-lady*. It appears, he says, at first like a small Blister, or little Knob upon the Leaves of the Shrub on which they breed, which afterwards by the Heat of the Sun become a *live Insect*, or small *Grub*. These *Grubs* in Process of Time become *Flies*, and being come to full Maturity, which must be found out by Experience, in collecting them at several Seasons, they kill by making a great Smother of some combustible Matter, to windward of the Shrubs whereon the *Insects* are feeding (having before spread some Cloaths under the *Plants*) whereby all the *Insects* being smother'd and kill'd by shaking the *Plants*, will tumble down upon the Cloaths; thus they are gathered in great Quantities with little Trouble. Then they spread them on the same Cloaths in some bare sandy Place, or stone Pavement, and expose them to the Heat of the Sun until they are dry, and their Bodies shrivelled up, which being rub'd gently betwixt ones Hands, will crumble into *Grains*, and the *Wings* separate from them, which must be garbled out. Others, 'tis said, do expose them to the Sun in broad and shallow *Copper Basins*, wherein the Reflection of the Sun will dry them sooner.

The *Tree* or *Shrub* on which they breed, call'd the *Prickle Pear*, or *Indian-Fig*, is easily and quickly propagated, by putting a single Leaf above half its Depth into the Ground, which seldom fails to take Root, and throw out other new Leaves at the Top thereof. Others say, they may be raised from the Seed or small Grains, which are to be found in the proper Season in the Fruit, which is something like a *Fig*, arising out of certain yellow Flowers, or Blossoms, that grow out at the Tops of the uppermost Leaves, which Fruit is full of a red Pulp, that, when full ripe, stains the Hands of them that touch it, like *Mulberries*, with a purple or sanguine Colour, whereon, or on the Blossoms, some say the *Insects* do feed; which haply may be the Occasion of that rich *Tincture* within their Bowels.

3. The Figures 191, 192, 193, represent the *Cochineel-Fly* as seen on its Belly by the help of the *Microscope*, and by the naked Eye; and as seen on its Back through *Microscope*.

Figures of the *Cochineel Fly*, by Dr. Tyson, n. 176. p. 1202. The *Death-watch*, by M. Ben. Al'en, n. 245. p. 376

XXIX. In *August* 1695. I traced a *Death-watch* by the Noise, and found it in a *Copper Body*; it resembled dry Dirt in Colour. I found another some Years before on a rotten Post. This small Beetle had another answered it in the same Room, and after a Minutes distinct beating would forbear for the other to answer.

H h h h h

The

The Part it beats with, is the extreme Edge of the Face ; which I may call the upper Lip, the Mouth being protracted by this bony Part, and lying underneath out of View.

Fig. 195. It was $\frac{1}{2}$ of an Inch long, the Colour a dark brown, with Spots, something lighter, irregularly placed, which would not rub off readily. They seemed to lie rather athwart the Back, and direct on the Head ; as in the small Figure, 194, which is much of the same size with it, and the *Maculae* are designed for the greyish Spots. Under the *Vaginae*, are pellucid *Wings*, and the Body is of a pullous Colour. The Head appeared large, by reason of a large Cap or Helmet, which covered it round, only at the Ear turned up a little ; from under this appeared the Head, which was flat and thin ; the Eyes forwards, the Lip hard and shining, the Ears of the *Helmet* greyish. Two *Antennae* proceeded from under the Eyes, which, by their meeting on the Breast, I conjectured to assist their Feeding, and to be rather Probosces ; and the *Helmet* to be turned up for hearing sake ; and the Belly plicated as other *Beetles*.

The other *Beetle* that answered it was less, and the Marks on the Back, not so distinct.

Fig. 195. By the *Microscope* I discovered the *Marks* to be thick set spots of Hair, of a Castor Colour ; the Head all hairy, and the Face thick of curled Hair. On the Belly was a little but thin set Hair. The Eyes appeared large, as in the Figure, the superficies consisting of many small squares furrow'd deep between, and these lay in Lines transversely descending towards the Nose. These Eyes were not moveable but contiguous to the Face, without any Cavity to receive them ; and they were very opaque. The *Antennae* proceeded from under the Eyes ; the first large Joint having a Cavity, out of which it proceeds at the sides of the Lip. Between the Eyes the Face rises in a little Ridge, which is the Nose, and is signified by the light part of the Face. And just below it, the *Nasrils* are covered by strait pendulous Hair, proceeding from the lower Ridge of the Nose. Under this Hair, the Cavity is dark. Below the Nose, the Lip shades shew the more deprest Places. Under this Lip are visible 4 *Forcipes*, 2 of each side, to lay hold on its Food.

The *Musca*
Lupus in *Vir-*
ginia. by Mr.
J. Banister.
n. 1780. p. 693

XXX. 1. I have observed, that that sort of Flies which *Mouffet* calls *Musca Lupus*, and some others, (as the *Tabani*, *Afli*, &c.) that have but 2 Wings, have growing out of their Body, under each Wing a small flexible *Apex* or *Pointel*, with which they poise their Body, and keep it in *Equilibrio*, as the *Dancer* on the *Rope* does with his Pole ; for pull these off, and their Flight is short and unsteady, nor can they, tho' they have the use of their Wings, guide themselves so, as to keep themselves from the Ground, or to avoid striking against whatever is in their Way.

2. Dr. *Hook* has observed these *Pendulums*, and described them in his *Micrographia*, Obs. 38. p. 273.

A Note, by
ib. p. 691,

XXXI. I here send you a *viviparous Fly*, which is one, if not the very biggest, of the harmless *Tribe* that I have met with *England*. I call them *harmless*, because that they are without that hard *Tongue* or *String* in the *Mouth*, with which the *Oestrus kind*, or *Gad-Flies*, trouble and offend both *Man* and *Beasts*. This *Fly* is striped upon the *Shoulders*, grey and black, and as it were checkered on the *Tail* with the same two Colours. The *Female* may be known by a *Redness* on the very *Point* of the *Tail*. The very latter end of *May* 1666, I opened several of them, and found 2 *Bags* of live white *Worms*, of a long and round Shape, with black *Heads*, they moved both in my *Hand*, and in the unopened *Vesicles*, backwards and forwards; as being all disposed in the *Cells* length-ways the *Body* of the *Female*, like a *Sheaf*. Some such thing is hinted by *Aldrovandus*, and I suspect all of this *Tribe* to be in some measure *viviparous*.

A vivi-
parous Fly, by
D. M. Lister
n. 72. p. 217.
n. 160, 595

Lib. 1. de In

XXXII. 1. In a great and very ancient Wall of *Free stone*, in the *Benedictines Abbey* at *Caen* in *Normandy*, facing southward, there are to be found many *Stones* so eaten by *Worms*, that one may run his hand into most of the *Cavities*, which are variously fashioned, like the *Stones* which I have seen wrought with so much *Art* in the *Louvre*; in these *Cavities* there is abundance of live *Worms*, their *Excrement*, and of that *Stone Dust* they eat. I have taken some of these living *Worms*, which I found in the eaten *Stone*, and put them into a *Box* with several *Bits* of the *Stone*; leaving them there together for the space of 8 *Days*, and then opening the *Box*, the *Stone* seemed to me eaten so sensibly, that I could no longer doubt of it.

A Kind of
Worms eat-
ing out
Stone, by M.
de la Veyr,
n. 18, p. 321.

These *Worms* are inclosed in a *Shell*, which is *grayish*, and of the Bigness of a *Barley-corn*, sharper at one end than the other. By the Means of an excellent *Microscope*, I have observed, that 'tis all overspread with little *Stones*, and little *greenish Eggs*, and that there is at the sharpest end a little *Hole*, by which these *Creatures* cast out their *Excrement*, and at the other End, a somewhat bigger *Hole*, thro' which they put out their *Heads*, and fasten themselves to the *Stones* they gnaw. They are not so shut up, but that sometimes they come out, and walk abroad. They are all black about 2 *Lines* of an *Inch* long, and 3 *qrs.* of a *Line* large. They are distinguish'd into several *Plyes*, and near their *Head* they have 3 *Feet* on each side, which have but two *Joints*, resembling those of a *Louse*. When they move, their *Body* is commonly upwards, with their *Mouth* against the *Stone*. They have a big *Head*, somewhat flat, and even of the Colour of a *Tortoise-shell*, brownish, with some small white *Hair*; their *Mouth* is also big, where may be seen 4 kinds of *Jaw-bones*, lying cross-wise, which they move continually, opening and shutting them like a pair of *Compasses* with 4 *Branches*; the *Jaws* on both sides of the *Mouth* are all black; the *Nether-Jaw* hath a *Point* like the *Sting* of a *Bee*, but uniform; they draw *Threads* out of their *Mouth* with their *Fore feet*, using that *Point* to range them, and to form their *Shells* of them; they have 10 *Eyes*, very black and round; which appear to be bigger than a *Pin's Head*; there are 5 of them on each side of the *Head*, standing as in the *Figure*.

Fig. 196.

H h h h h 2

2. I

Another sort
eating Mortar,
ib. p. 3.

2. I have also found, that *Mortar* is also eaten by an infinite Number of small Creatures, of the bigness of *Cheese-mites*; these have but two *Eyes*, and are blackish; they have 4 Feet on each side pretty long; the Point of their *Muzzle* is very sharp, as that of a *Spider*. In old *Mortar* betwixt Stones, that is found in Walls made with *Rubbish*, there is a great Store of them together with great Plenty of their little Eggs: You may observe more of them in Walls exposed to the South, than in others, and that the *Worms* that eat the Stone, live longer than those that eat the *Mortar*; which keep not above 8 Days alive. Without a very good *Microscope*, and a great deal of *Attention*, 'tis difficult to see them well.

I have seen other very old Walls altogether eaten, as those of the *Temple* at *Paris*, where I could find no *Worms*: But the Cavities were full of *Shells* of various kinds, diversly figured, and turned; all which I believe to be little *Animals* petrify'd.

Of Scolopendra,
by M.
J. Ray, n. 7.
p. 222.

XXXIII. The *Scolopendra*, which is by *Bruerus* ascribed to *Muffet*, in the latter part of his Chapter *de Julis*, p. 202. I saw in the Cloysters of *Trinity* College in *Cambridge*, 12 or 13 Years ago.

A swarm of
Flying Grass
hoppers in
Languedoc,
by - com-
municated by
Mr. Juffel, n.
182, p. 147.

Vid. sup.
§. 21, 22, 23.

XXXIV. These *Insects* appear to Sight, in nothing different from the common sort of *Grasshoppers*; but they take their Flight like *Birds*, which is particular to them. They are much about an *Inch* in length, of a grey Colour. In the Year 1685, the *Earth* in some places about *Aramont* in *Languedoc*, near *Avignon*, was covered 4 *Fingers* thick with them, in the Morning before the Heat of the *Sun* was considerable: But as soon as it began to be hot, they took Wing and fell upon the Corn, eating up both Leaf and Ear, and that with such Expedition, by reason of their great Number, that in 3 hours they devour'd the Corn of a whole Field; after which, they again took Wing, and their *Swarms* were so thick, that they covered the *Sun* like a Cloud, and were whole Hours in Passing. They flew against the Wind, and went over the *Castle*, which is very high, and seized upon another Field of Corn, which they destroyed like the former. After having eaten up the Corn, they fell upon the *Vines*, the *Pulse*, the *Willows*, and even the *Hemp*, notwithstanding its great Bitterness. Afterwards, about the end of *August*, they ceased flying, and copulated, and the Female stuck her Tail into the hard *Earth*, where she cast a Foam, and made therewith in the Ground a Hole, as big as that of a *Goose-quill*, and about an *Inch* long, wherein she laid her Eggs, which are much of the size of *Millet-seed*; there would be sometimes 50 of these Eggs in a Hole, which are so covered over with the same *Earth*, that the Water does not get in. After this, all these *Insects* died, and stunk very much. They began to hatch in *April*, 1686. In *March*, we thought upon Destroying their Eggs, which lie not above a *Fingers* breadth in the *Earth*; and we took of them 118 *Quintals*, being 9 *Tuns*. Since their Hatchings, they have taken above 15 *Tuns* of the young *Grasshoppers*, which are not yet bigger than *Flies*: And there are yet a Multitude

titude that have escaped us. If this Care had not been taken, there would have been enough of them to have eaten up the Corn of the whole Province.

XXXV. *Fleas* bring forth *Eggs* (or a sort of *Nits*) from these *Eggs* are hatched *Worms*; these *Worms* make to themselves *Bags* like *Silk Worms*; and from out of these *Bags* come *Fleas*. The *Eggs* they deposite on *Dogs*, *Cats*, *Men* or other *Animals* infested with them: or in *Places* where they sleep, which being round and smooth, slip ordinarily streight to the Ground. or fix themselves on the *Plyes*, or other *Inequalities* of the *Coverlets* and *Cloaths*. From these are brought forth *white Worms* of a shining Pear Colour, which feed themselves on the *Bran like Substance* which sticks in the Combs when *Puppies* are combed to take out the *Fleas*, or with a certain downy Substance, that is found in the *Plyes* of *Linen Drawers* or other such like Excrement. They come in a Fortnight to the bigness of Fig. 197. and are very lively and active, and if they have any Fear, or if they be touched, they suddenly roul themselves up, and make as it were a Ball. A little after, they come to creep, after the manner of the *Silk Worms* that have no Legs, with a brisk and very swift Motion. When they are come to their usual bigness they hide themselves the most they can, and bringing out of their Mouths the Silk, they make round themselves a small Bag, white within as Paper, but without always dirty, and foul'd with Dust. The *Bags* are to the naked Eye of the bigness of Fig. 198. without magnifying. In other two Weeks, in the Summer-time, the *Flea* is perfectly formed; without that the *Worm* quits its *Exuvia* in its Bag; as do the *Silk Worms*; and as do all *Caterpillars*, which leave in the same their *Exuvia*. The *Flea*, so long as it is inclosed in the Bag, is milk white, altho' it has its Legs; but two Days before it comes out, it becomes coloured, grows hard, and gets Strength, so that coming speedily out, it streight leaps away.

Fig. 199. Represents the *Eggs*. Fig. 200. The *Worm*. Fig. 201. The *Bag*. Fig. 202. the *Flea*; but all magnify'd by the *Microscope*.

XXXVI. There have occurred to my Observation but 3 sorts of *Ants*, commonly without Wings; viz. very black, dark brown and *Philemort*. Each kind inhabit by themselves in their several Banks, two sorts seldom or never being found together; and if either of the other two sorts be put into the black *Ants* Bank, 'tis worth observing what Enmity there is betwixt these little Creatures, and with what Violence the black Ones will seize on the red, never leaving to pinch them on the Head with their Forceps, or Claws, till they have killed them upon the place; which done, they will carry them dead out of the Field, from their Bank. But if you put black *Ants* into a Bank of the red, the black seem to be sensible of the strangeness of the Place they are in, that there they will not meddle with the red; but as if they were frighted, and concerned for nothing but Self-preservation, run away.

Upon opening of these Banks, I observe first, a white Substance, which to the bare Eye looks like the scattering of fine white Sugar or Salt, but very soft

The Generation of Fleas, By S. Diacon, &c. Cestione! n. 245. P. 12

Fig. 198.

The Emmet or Ant, By Sr Edmund King, n. 23, p. 425.

soft and tender. And if you take a bit of it, as big perhaps as a *Mustard-Seed*, and lay it on the *Object Plate* of a good *Microscope*, you may by opening it with the Point of a Needle discern many pure, white and clear Appearances in distinct *Membranes* all Figured like the lesser sort of *Birds Eggs*, and as clear as a Fish's Bladder. This Substance, as it hath been just now described, I find in the *Ants* themselves; which I take to be the true *Ants-Eggs*: It being obvious to the Observation, that wherever this is uncovered, they make it their Business to carry it away in their Mouths to secure it, and will, after you have scattered it, lay it on a heap again, with what speed they can. I observe they lie in Multitudes upon this, (if I may so call it) Spawn of theirs: And after a little time every one of these small Adherences is turned into a little *Vermicle*, as small as a *Mite*, hardly discerned to stir. But after a few Days more, you may perceive a feeble Motion of Flexion and Extension, and they begin to look yellowish and hairy, shaped very like a small Maggot: And so keeping that shape, grow almost as big as an *Ant*, and have every one a black Spot on them. Then, they get a Film over them, whitish and of an Oval shape; for which Reason, I suppose, they are commonly called *Ants-Eggs*; which yet (to speak properly) they are not.

I have opened many of these, vulgarly call'd *Ants-Eggs*, I mean the lesser sort, (for there are some as big as a *Wheat Corn*, others less than a *Rye Corn*) and in some I find only a Maggot to appearance just as was described before. In others, I find a Maggot, beginning to put on the shape of an *Ant* about the Head, with two little yellowish Specks, where the *Eyes* are designed, in others a further Progress, and furnish'd with every thing to compleat the Shape of an *Ant*: But wholly transparent, the *Eyes* only excepted, which are then as black as black *Bugles*. But when they newly put on this Shape, I could never discern the least Motion, in any one part of the little Creature, whereof the Reason may perhaps be the Weakness of their *Fibres*; for after a little more time, when they begin to be brownish, they have Strength to stir all their Parts. At last, I met with some of these reputed *Eggs*, which being carefully opened by me, I took out of several of them every way perfect and compleat *Ants*, which did immediately creep about, among the rest, no way differing from many other *Ants*, but by a more feeble Motion of their Limbs. And this I took for a clear Demonstration of what I designed, which was to know, that the *Film* does only cover the *Maggot*, while she is Transforming into an *Ant*, and fit to shift for herself. The black Speck, that is at one end of every such reputed *Ants Egg*, I suppose to be cast out of the *Maggot*, in her Transformation: Since after it puts on the Shape of an *Ant*, the *Speck* is quite gone, and the whole Body of the *Ant* pure clear; since also this *Speck* at the end of the said *Egg*, lies always close to the *Anus* of the included *Ant*.

It is observable how upon a breaking up of their *Banks*, they make it their business immediately to carry their Young out of sight again; laying the several sorts of them in several Places and Heaps; the which if you mingle again, or scatter, you shall, laying but some bits of Slate, or the like, in

in any place they may come to and get under, after a few Hours see all the *Vermicles* and vulgarly called Eggs, laid in their several and distinct Parcels under such Pieces of *Slate*, &c. Provided the place be not so cold as to chill their Limbs ; which if it be, by being brought to the Fire, they will soon recover their Strength, and fall to their business again, of securing their little Ones. They know all the sorts of their Young so well, that you cannot deceive them though you may with *Fine Sugar*, *Salt*, or the Crumbs of very *White Stale Bread*, scattered in the Mould, where their first true Eggs are, as I call them, be mistaken your self, yet the *Ants* will not, nor touch a bit of what is not their own Offspring.

I have observed in Summer that in the Morning they bring up those of their Young (that are vulgarly call'd *Ants Eggs*) towards the top of the Bank : so that you may, from 10 in the Morning until 5 or 6 in the Afternoon, find them near the top ; especially about one, two, or three of the Clock, and later, if the Weather be hot ; when for the most part they are found on the South side of the *Bank*. But towards 7 or 8 at Night, if it be Cool or likely to Rain, you may dig a Foot deep before you can find them.

XXXVII. Dr. *Hulfe* in Aug. 1670. sent me these Observations ; “ Bare
“ an *Ant-Hill* with a *Stick*, and then cast *Cichory Flowers* upon it, and you
“ shall see the *Ants* creep very thick over them ; now as they creep, they
“ let fall a drop of *Liquor* from them, and where that chanceth to light,
“ there you shall have in a Moment a large red Stain. Sometimes they
“ will be a pretty while before they discolour them, and at other times,
“ they will do it suddenly. At the first I guessed that being vext, by stir-
“ ring their Hill, they might thrust their Stings into the Flowers, and
“ thorow them convey that *Sharp Liquor* : but by bruising them, and rub-
“ bing the expressed Juice against the Flowers ; I find they will be equally
“ stain'd. 'Tis a thing well known, that *Ants*, if they get into Peoples
“ Cloaths, and so to their *Skin*, will cause a *Smart* and *Tingling*, as if they
“ were nettled ; which I conceive is done by letting fall the forementio-
“ ned *Corrosive Liquor*, rather than by *Stinging*.

“ To what sort of *Liquor* to refer this Juice, I know not. I dropt *Spirit*
“ of *Salt*, and *Oyl* of *Sulphur* upon the Flowers ; but they did not cause
“ them to change Colour. I likewise put *Salt* of *Tartar* upon them, and
“ dropt thereon a little *Spirit* of *Salt*, which caused a sufficient *Fermentation* ;
“ but prevailed not to change the Colour of the Flowers in the least.

“ This Observation holds true, not only in *Cichory Flowers*, but also
“ *Lark-Spur*, *Borage*, and all others of a *Blue Colour*.

Some Years since Mr. *Sam. Fisher* of *Sheffield*, made me acquainted with these Experiments, viz. “ If with a Staff, or other Instrument you stir an
“ Heap of *Ants*, (especially *Horse-Ants*) so as to anger them, they will let
“ fall thereon a *Liquor*, which if you presently smell to, will twinge the
“ Nose like newly distilled *Spirit* of *Vitriol*.

“ A Weak *Spirit* of *Pismires*, will turn *Borage Flowers* red in an Instant ;
Vinegar

The Acid
Juice of P.
mires, by M.
J. Wray, n.
68. p. 2053.

" *Vinegar* a little heated, will do the like. *Pismires* distill'd by themselves, or with *Water*, yield a *Spirit*, like *Spirit of Vinegar*, or rather like the *Spirit of Viridi Aeris*; *Lead* put into this *Spirit*, or *Fair Water*, with the *Animals* themselves being alive, maketh a good *Saccharum Saturni*. *Iron* put into the *Spirit*, affords an *Astringent Tincture*, and by a *Repetition* a *Crocus Martis*. Take *Saccharum Saturni* thus made, and distill it, and it will afford the same *Acid Spirit* again, which the *Saccharum Saturni* made with *Vinegar* will not do; but returns an *inflammable Oil* with *Water*, and nothing that is *Acid*. *Saccharum Saturni* made with *viridi Aeris*, doth the same (in this Respect) with that made with *Spirit of Pismires*. When you put the *Animals* into *Water*, you must stir them to make them *angry*, and then they will spirt out their *acid Juice*. No *Animal* that we ever distilled (he speaks of his Brother and himself) except this, yields an *acid Spirit*, but constantly an *Urinous*; and yet we have distilled many, both *Flesh*, *Fish* and *Insects*.

In Dr. Hulse's Account, where he saith, that *Spirit of Salt*, and *Oil of Sulphur* dropped upon *Cichory Flowers*, did not cause them to change Colour, it is to be understood of the Flowers entire and unbruised: For any blue Flowers being a little bruised, and then a Drop of *Spirit of Salt*, or any other *Acid Spirit* let fall thereon, will turn instantly red. The Reason is obvious; for that the Leaves of the Flowers (as all the other parts of the Plant) being invested with a *Skin* or *Membrane*, the *Liquor* drop'd thereon cannot easily penetrate it, and so commix it self with the *Interiour Juice* or *Pulp*. Hence it is, that if these Flowers be put into *Cold Vinegar*, especially if the Weather be cool, they will not change Colour for a considerable time; but if you heat the *Vinegar*, they will change immediately.

Another Insect yielding an acid Juice, by Dr M. Lister, ib, p. 2057.

2. Having observed that a *Pismire* bruised and smelt to, emits a strange fiery and piercing Savour, like the Leaf of the Herb, by Botanists call'd *Flammula*, broken at one's Nostrils, I have by this means found an *Insect*, which I suspect, may yield an *acid Liquor*, as well as the *Pismire*; and that is the long and round bodied red colour'd *Julus* distinguished from all other *Multipeds*, in that their innumerable Legs are as small as a Hair, and white, and in going they are moved like Waves; not rare amongst dry Rubbish; no *Scolopendra*, ours being an *Harmless Insect*, and that armed with *Dangerous Forcipes*. The Body of this *Julus* being bruised strikes the Nostrils exceedingly fiercely.

Musk Scented Ants, by Dr. Lister, p. 77. p. 3002. Vid. Sup. §. XXVI. & XXVII.

XXXVIII. Sep. 2. 1671. I found in a sandy Ditch-bank about a Mile and an half from York, in the high Road to London, a sort of exceeding small *Pismires* (by which Note alone I think they may be sufficiently distinguish'd from all, at least, that I have seen.) Those without Wings, were of a Light Yellow, or Flaxen, and being broken at ones Nostrils they emitted, like others, an acid or sowre Scent, but those of the same Bank with Wings, were Coal Black, and those bruised and smelt to, emitted a fragrant Smell like Musk; And an Apothecary in York, famous for his Diligence in Chymical Operations, did

did compare them (unseen and not yet made known to him) to an Excellent Balsam, he is wont to prepare.

vel *Fila mittunt* ; ut sunt qui
aut *Prædandi causa Texunt* !

vel *Reticula Orbiculata*, Numero IX.

1. *Araneus Subflavus*, Alvo paululum Acuminata inflexaque.
2. *Araneus rufus*, *Cruciger*, cui utrinque ad superiorem Alvi partem velut Singula Tubercula eminent.
3. *Araneus Cinereus*, *Pictura Clunium* in 5. fere partes divulsa, iisque plenis admodum.
4. *Araneus Flavus*, 4. Albis præter *Picturam Foliaceam*, in Clune Maculis insignitus.
5. *Araneus Nigricans*, Clunibus ad Similitudinem *Querni Folii* pictis.
6. *Araneus ex viridi Inauratus*, Alvo prætenui proceraque.
7. *Araneus Cinereus*, Sylvarum incola, alvo in Mucronem fastigiata, seu *Triquetra*
8. *Araneus Viridis*, Cauda *Nigris Punctis* superne notata, ipso Ano *Croceo*.
9. *Araneus Pullus Cruciger* in alvo plena.
vel *Plagas Globatas*, N. IV.
10. *Araneus Variegatus*, alvo Orbiculata.
11. *Araneus Rufus*, Clunium Orbiculatum fastigio in modum *Stellæ Radiato*.
12. *Araneus Pullus Domesticus*.
13. *Araneus Cinereus* Macula *Nigra* in summis Clunibus insignitus, *Minimus*.
- vel *Telas sive Linteamina*. N. VIII.
14. *Araneus Subflavus*, Pilosus, prælongis pedibus, Domesticus.
15. *Araneus Nigricans*, Prægrandi Macula in summis Clunibus, cæterum iisdem oblique virgatis, Domesticus.
16. *Araneus Fuligineus* e Craven, insigni Candore distinctus, Cauda Bifurca.
17. *Araneus Subflavus*, *Nigricantium* Macularum Quadratarum Catena in Clunibus insignitus ; item cui utrinque ad Clunium Latera singulæ obliquæ Virgulæ *Flavescentes*.
18. *Araneus Cinereus*, Maximus, Cauda Bifurca.
19. *Araneus Niger* aut *Castaneus*, Glaber, Clunibus summo Candore interstinctis.
20. *Araneus Cinereus*, Mollis, cui in alvo, oblique virgata, Macula latiuscula e Nigro rubens.
21. *Araneus* plerumque *Lividus* sine ulla *Pictura* alvo Acuminata. aut ideo *Nihil Texunt* (nisi *florum Ejaculatio* ac *Volatus* illorum spectet :) cum tamen alias possint ; pimirum *Telas* ad *Tutandum Fatum* aut ad *Hyberna* ; sed aperto Marte *Muscas* venantur, atque ii sunt.

Iiiii

vel

A Table of
Spiders
found in Eng-
land, By Dr
M. Liber, n.
72. P. 2175.

vel *Lupi dicti*, N. V. Hi vero, cum Superioribus singulis 8 habent Oculos.

22. *Aranæus subrufus*, Parvus, citissimo Pede.

23. *Aranæus Cancriformis*, oculis e *viola purpurascens*ibus, Tardipes.

24. *Aranæus cinereus*, Alvo undulatum *Picta*, insigniter Procera, Acuminata.

25. *Aranæus Fuscus*, albo oblique virgata.

26. *Aranæus Niger*, Sylvicola.

vel *Phalangia*, sive affultim ingredientes, N. III. Hi vero 6 tantum Oculos habent.

27. *Aranæus Cinereus*, sive ex *Argento Nigroque Varius*.

28. *Aranæus Subflavus*, Oculis *Smaragdinis*; item cui secundum Clunes 3. virgulæ *Croceæ*.

29. *Aranæus subrufus* e *Craven*, sive *Ericetorum* sive *Rupium*, vel omnino *Nulla Fila mittunt*, ut sunt qui plerique.

Longissimis Tenuissimisque *Pedibus* donantur; atque Hi duos tantum Oculos habent *Telaque* sive *Brachia Digitata*. N. IV.

30. *Aranæus Rufus*, non *Cristatus*, Gregatim vivens.

31. *Aranæus Cinereus*, *Cristatus*.

32. *Aranæus* e *Candido Nigroque Varius*, *Minima Bestiola*, *Sylvicola*.

33. *Aranæus*, ut puto, *Coccineus*, vulgo dictus, a *Tant*, *Anglice*.

Spiders
darting their
Threads into
the Air, and
Swimming
in it, By Dr
Lifter, n. 50.
P. 1014.

XL. I. I have discover'd that all *Spiders* that spin a Thread, (those which we call *Shepherds*, or *Long Legg'd Spiders*, never do,) are the *Makers* of those *Long Threads in the Air in Summer*, and especially towards *September*, so much wondred at, and in such infinite Quantities every where. I exactly marked all the ways of Weaving, used by any sort of them, and in those admirable Works, I ever noted, that they still let down the Thread they made use of, and drew it after them.

At length in nearly attending on one that wrought a Net, I saw him suddenly in the mid Work to desist, and turning his Tail into the Wind to dart out a Thread, with the Violence and Stream we see *Water* spout out of a Spring. This Thread, taken up by the Wind, was in a Moment emitted some Fathoms long, still issuing out of the Belly of the Animal; by and by the Spider leapt into the Air, and the Thread mounted her up swiftly. After this first Discovery, I made the like Observation in almost all the sort of Spiders, I had before distinguished; and I found the Air filled with young and old, sailing on their Threads, and undoubtedly seizing *Gnats* and other *Insects* in their Passage; there being often as manifest signs of slaughter, as *Legs*, *Wings* of *Flyes*, &c. on these Threads, as in their Webs below.

One thing yet was a wonder to me, viz. that many of these Threads, that came down out of the Air, were not single but snarled, and with Complicable woolly Locks, now more now less, and that on these I did not always find Spiders, though many times I had found two or three upon one of them

them ; whereas when they first flew up, the Thread was still single, or but little tangled, or it may be thicker in one place than another. In the end by good Attention, I plainly found them to get to the Top of a Stalk or Bough, or some such like thing, where they exercise this darting of *Threads* into the Air ; and if they had not a mind to sail, they either swiftly drew it up again, winding it up, with their Fore-feet over their Head into a Lock, or break it off short, and let the Air carry it away. This they will do many times together : and you may see of them that have Chains of these Locks or snarled Thread before them, and yet not taken Flight.

Again, I found that after the first Flight, all the time of their Sailing, they make Locks, still darting forth fresh supplies of *Thread*, to sport and sail by.

It is further to be noted, that these complicated Threads, are much more tender than our *House Webs*.

In *Winter* and at *Christmas*, I have observed them busy a Darting : but few of them sail then, and therefore but single Threads only are to be seen. And besides, they are but the *young Ones*, of last *Autumns Hatch*, that are then employed ; and it is more than probable, that the great *Ropes* of *Autumn* are made only by the great Ones, and upon long Passages, and *Summer* Weather, when great Numbers of *Prey*, may invite them to stay longer up.

2. I have seen Spiders shoot their Webs ; Yards long before they begin to sail ; and then they will, as it were, fly away incredibly swift. Which *Phænomenon* doth somewhat puzzle me ; seeing sometimes the Air doth not move a quarter so fast as they seem to fly. Mostly they project their Threads single, without dividing or forking at all to be seen in them. Sometimes they still shoot the Thread upward, and will mount with it in a Line almost *Perpendicular* ; and at other times they project in a Line *Parallel* to the Plain of the *Horizon* ; as you may often see by their Threads that run from one Tree to another, and likewise in Chambers from one Wall to another.

I confess, this Observation at first made me think, that they could fly : because I could not perceive, how a Thread could be drawn so parallel to the *Horizon* between two Walls or Trees, as above said, unless the Spider flew through the Air in a straight Line.

The way for forking their *Threads*, is expressed by the Figure. What Reason should be given of this Dividing, I know not, except that their *Threads* being thus winged, become better able to sustain them in the Air.

They will often fasten their *Threads* in several Places to the Things they creep upon ; The manner is, by beating their *Tails* against them as they creep along, which may be understood by the Line *a, b*. By this frequent Beating in of their Thread among the Asperities of the Place, where they creep, they either secure it against the Wind, that it be not easily blown away ; or else whilst they hang by it, if one stick breaks, another holds fast, so that they do not fall to the Ground.

By Dr. Hulse.
B. 65. A. 2103

Fig. 205.

Fig. 204.

By Mr. J.
Wray, ib.

3. I had the first Notice of this Darting of Spiders from Dr. *Hulse*, which was not long after communicated to me by Mr. *Lifter*; nor is it any great Wonder, that inquisitive Persons, applying themselves to observe and consider the same Subjects, should make the same Discoveries.

By ——— ib.
P. 2104.

4. Mr. *Lifter* intimates in a later Letter, that Mr. *Wray* knew nothing of his having observed the darting of Spiders, no more than he knew that either Mr. *Wray* or any body else had observed it, until such time as he occasionally sent Mr. *Wray* a Catalogue of our *English* Spiders, upon which Subject Mr. *Wray* put this among other Questions; whether he had observed the Darting of Spiders.

Whence it appears that this Observation is as well Mr. *Lifter's* as Dr. *Hulse's*.

By Dr. L.
Ser. n: 160.
P. 192,

5. I take the Forking of some Threads (for Dr. *Hulse* excepts the most) to be merely accidental, even as it is to our Hair: Neither do I think that any such thing is designedly done by the Animal, and for as much as I have observed, Spiders Threads of themselves are exceeding slick and smooth. There is indeed a dividing in the Projection of the Threads of many sorts of Spiders, and especially among those which we distinguish by the Name of *Lupi*, which Tribe is most frequent, and particularly delighted in Sailing, yet this Dividing is much of another Nature than Forking. These *Lupi* will dart a whole *Stamen* or *Sheaf* at once, consisting of many *Filaments*: Yet all of one length, all divided each from the other, and distinct until some chance either snap them off, or entangle them. But for the most part you may observe, that the longer they grow, the more they spread, and appear to a diligent Observer like the numerous *Rays* in the Tail of a *Blazing Star*. As for that which carries them away in the Air, so swift off hand, it is, as I have already hinted, partly their sudden Leap, and partly the length and number of the *Threads* projected, the Stream of the Air and Wind beating more forcibly upon them: And thus we see a Rope that unexpectedly slips, comes home with a seeming Violence, and partly (and that much too) the Posture and Management of their Feet, which, at least by some sort of them, I have observed to have been used very like Wings or Oars, the several Legs like our Fingers, being sometimes close Joyned, and other times opened, again bent, or extended, &c. according to the several Necessities and Will of the Sailer. To fly they cannot be strictly said, they being carried into the Air by external Force, but they can, in case the Wind suffer them, steer their Course, and perhaps mount and descend at Pleasure: and to the purpose of Rowing themselves along the Air, 'tis observable, that they ever take their Flight backwards, that is, their Head looking a contrary way, like a Sculler upon the *Thames*. It is scarce credible to what Height they will mount: Which yet, is precisely true, and a thing easily to be observed by one that shall fix his Eye, some time on any part of the Heavens, the white Webs at a vast Distance very distinctly appearing from the Azure Sky: but this is in Autumn only, and that in very Fair and Calm Weather.

XLI. S. Redi having affirm'd, that Creatures reputed *venemous* are indeed *no Poysons* when swallowed, tho' they may prove so when put into *Wounds*, Mr. Nath. Fairfax, for Confirmation thereof, alledges Examples of several Persons well known to him, (himself also having been an Eye-witness to some such Experiments) who have frequently swallow'd *Spiders*, ven of the *rankest kind*, without any more Harm than happens to *Hens*, *Robin-red-Breasts*, and other Birds, who make *Spiders* their daily Commons. And having made mention of some Men that eat even *Toads*, he adds, that tho a *Toad* be not poyson to us in the whole, yet it may invenom outwardly; according to some parts so and so stirr'd, an Instance whereof he alledges in a Boy, who stumbling on a *Toad*, and hurling Stones at its some Juice from the bruised *Toad* chanced to light upon his Lips, whereupon they swell'd, each to the Thickness of about 2 Thumbs; and he neglecting to use what might be proper to restore them, they have continued in that mishapen size ever since.

The Innoxiousness of Spiders and Toads, by Dr. Nath. Fairfax, n. 22. p. 392.

XLII. Mr. Nath. Fairfax relates, that a *Spider* bruised into a small Glass of Water, tinged it somewhat of a sky Colour: and he is informed, that a Dozen of them being put in, they would dye it almost a full Azure.

Spiders tinge Water of a sky-Colour, by Dr. Fairfax, n. 12. p. 219. The Answer of a Rat to the Snake, by Dr. Edw. Tyson, n. 144. p. 25.

XLIII. Upon the Dissection of a *Rattle Snake*, which was sent alive from Virginia to Mr. Hen. Loades, a Merchant in London, I find both its external and internal Parts so conformable in almost all Respects to those of a *Viper*, that I have taken the Liberty of placing it in that Class, and from the *Rattle* which sufficiently differences it from other *Serpents*, of naming it *Vipera caudifona*.

It was 4 foot 5 Inches long, the Girth of the body in the largest Place, which was the middle, was 6½ Inches; the Girth about the Neck 3 Inches, near the *Rattle* 2 Inches, the Head flat on the top as in the *Viper*, and by the Protuberance of the *Maxilla*, somewhat representing the Head of a bearded Arrow, at the Extremity of it were the Nostrils; between them and the Eyes but somewhat lower, were two other Orifices, which I took for the Ears, but after found, they only led into a Bone that had a pretty large Cavity, but no Perforation.

Fig. 209. a

The Eye was round, about ¼ of an Inch Diameter: There was a large Scale jetting over the Eye, which seemed to serve as a *Palpebra* for defending it from any thing falling on it, but I could not perceive 'twas capable of closing, though inwards it seem'd to have a *Membrana Nictitans*, which removes any Dust that might adhere to the Eye.

Fig. 209. b

The Scales on the Head were the smallest of any; those on the Back larger; and so proportionably greater to the biggest part of the Body, and so diminishing thence again to the setting on of the *Rattle*, all in Figure somewhat resembling *Parship-Seeds*. Their Colour was various, those on the Head like

like the Colour of the *Feathers* on the Back of a *Green Finch*, speckled with small black *Spots*, whereof there were 4 larger and more remarkable : Those on the Back were of a dark *Feuilletmort*, a black and a darkish yellow, and speckled, making a curious *Chequer* or *Dappling* on the Back by this intermixture of Colours ; but as they grew nearer the *Tail*, they became darker, and at last almost black. The *Scales* on the Back had an edged rising in the middle, which was still less protuberant as they grew nearer the Sides, where they were flat.

The *Belly* seem'd flat, covered with long *Scales* of a yellowish Colour, speckled black. From the *Neck* to the *Anus*, we numbred 168. beyond the *Anus* were 2 half *Scales*, thence 19 whole *Scales* of a black Lead Colour, with yellowish *Edges* : from thence to the *Rattle*, 6 Orders or Rows of smaller *Scales* of the same Colour. The *Scales* of the *Belly* were joined to each other by distinct *Muscles* ; the lower *Tendon* of each *Muscle* being inserted upon the upper Edge of the following *Scale*, and the other *Tendon* of the same *Muscle* inserted about the middle of the foregoing *Scale*. These *Muscles* were more fleshy towards the Middle of the *Scale*, and then its *Fibres* did run obliquely ascending. To each side was appropriated a *Rib*, whose Point did join with the Extream of it, which must much advantage the use Nature seems to design them for, by strengthening them to perform their *Reptile Motions* ; for the *Scales* are so many Feet, which being free and open downwards, they thereby take hold of the Ground, and so contract their Body forwards, and then shoot out again ; and so perform their Motion. Hence it is, that on Rocks their Motion is much quicker than on the *Earth*, or *Plains*, because here they have the firmer Footing ; but in soft Ground, tho' their *Belly* be flat, yet they can contract it to an *Ellipsis*, or an acute Angle, that so they may take the deeper Hold, as I have observed in a *Viper*. This Coat of *Armour* (for their Defence) is so curiously contrived, that tho' it covers the whole Body, yet by its frequent Jointings it admits of all Motions.

Having placed this *Rattle Snake* on its Back, we opened it, and observed, that the *Tendons* of the *Abdominal Muscles* made a *Linea alba*, in the midst of the *Scales* of the *Belly*, where likewise did run a large Blood Vessel, arising from the *Vena Cava*, towards the lower part of the *Liver*.

The *Wind-pipe*, which is common to it with the *Viper* kind, as soon as it enters the *Breast*, presently meeting with the *Lungs*, consists only of *semi-annular Cartilages*, which being joined at both Ends to the Membrane of the *Lungs* inwardly is quite open, and immediately transmits the Air to the *Vesiculae* of the *Lungs* : For dividing the *Wind-pipe*, we perceived it easily extended above $1\frac{1}{2}$ Inch wide ; whereas before it meets with the *Lungs* the *Cartilages* are *Annular*. The *Trachea* or *Wind-Pipe* was 20 Inches long, terminating near the *Heart*, and Beginning of the *Liver*, and reaching to that Part of the *Lungs* which made the *Great Bladder*. The *Cartilages* of the *Trachea*, near the Beginning were $\frac{1}{4}$ of an Inch, but toward the End $\frac{1}{8}$ of

of an *Inch*, and lying flattish from End to End. These *Cartilages* were not so distinct as in other *Animals*, but often running into one another.

The *Lungs* begin from the *Tbroat* and run down 3 Foot in length; the upper part of them that lay in the fore part of the Body for the length of a Foot, and did reach to the *Heart*, was made of small *Vesiculæ*, or *Cells*, like the *Lungs* of a *Frog*; but from the frequent Branchings and Chequer of the *Blood Vessels* there, appeared of a florid red. This Part tapers proportionably to the Body: the lowest part of it near the *Heart* moderately blown, was in Compass $5 \frac{1}{2}$ *Inches*, a little lower, for the space of 4 *Inches*, the *Cells* gradually disappeared, so that they seemed at last to form only a *Reticular Compages* of *Valvulæ conniventes* on the inside of the *Membrane* of the *Lungs*, and the Compass of the greatest Place here, was about $6 \frac{1}{2}$ *Inches*, but from thence to the End of the *Lungs*, was only a large bladder, without any *Cells*, composed of a thin, but a strong transparent *Membrane*, the Compass of which, blown as the former was $8 \frac{1}{2}$ *Inches*. Fig. 205, 6.

The *Lungs* of the *Salamandra Aquatica*, and some other *Animals*, are only two large bladders; in the *Frog*, *Crocodile*, &c. are two large *Lobes*, fill'd with membranous *Vesiculæ*, or *Cells*. Our *Rattle-snake*, and all that Family, tho' they have but one *Lobe* of *Lungs*, yet in that they comprise the 2 former sorts; the fore Part being filled with numerous *Vesiculæ*, the latter an entire large Bladder.

In the *Land Tortoise* there are 2 *Lobes*, one on each side; but these are subdivided into several others, according to the Partitions of the *Ribs* that are fixed to the *Shell*, and they lie chiefly in the *belly*, that is, the lowest Part of the Body. But what I would remark is, that where the *Bronchiæ* first enter these Subdivisions 'tis *Reticulous*, then they form a large Cavity, so that in these *Animals*, where the *Nixus* of *Respiration* is not so frequent, Nature provides a sufficient Store-house for this so necessary a *Pabulum Vitæ*, in these larger Bladders, whence 'tis dispensed according to the Exigency of the *Oeconomia Animalis*. For the *Tortoise*, *Viper*, *Rattle Snake*, *Frogs*, *Toads*, &c. which sleep a great part of the Year, as before they betake themselves to this Repose, they take in their Store of Food, so perhaps that of Air too; a more constantly requisite Supply of Life. For when thus stupidly asleep, and sometimes to all appearance dead, it may be questioned whether they have any Motion of those Parts, which is required in drawing in fresh Air in Inspiration. But since their Life here is so imperceptible and small, this Stock may be sufficient, the Decay being so little. So, the *Salamandra aquatica*, that lives under Water, for *Lungs* has two large Bladders, not unlikely for this Reason, that it might not be forced so often to raise it self out of the Water to breathe in fresh Air, when the former is spent and decayed.

In a *Viper* I lately dissected, (which remained alive some Days after the *Skin*, and most part of the *Viscera* were separated) I observed the *Lungs* all this while not rising and falling, as in *Inspiration* and *Expiration*, but constant, equally extended with Air, and that as soon as it died, it expired and they

they fell. But the Stomach was empty, and I doubt not was so some considerable time before, as was the *Rattle-snakes*, which for 4 *Months* at least had eaten nothing, so that altho' they can live so long without Food, yet Nature is mighty provident in supplying them with Air, in bestowing on them so large Receptacles for receiving it. So the *Ephemeron*, the *Silk-worm* and other *Butterflies*, which all their Life-time, when in that State, do not eat, or take in any Food, yet have their *Bronchiæ* or Lungs remarkably large and numerous; as if they were sufficient alone for maintaining their Life, for if they be occluded with Oil, or otherwise, they are strait suffocated and die convulsed.

The *Oesophagus*, or *Gula*, which serves only in most other Animals for transmitting the Food into the Stomach, seems here to be intended by Nature for something more; for upon blowing up this Part, I observed two large Swellings, nor was the true *Stomach* capable of that Extention as these were. The whole length of the *Oesophagus* was 2 Foot $3\frac{1}{2}$ Inches; the length of the proper Stomach 5 Inches, lying in a strait Line with the *Oesophagus*, but thicker than it, having a remarkable Coat more on the inside, easily distinguishable by its Colour, Substance, and *Plicæ*, and jutting over the inside of the *Gullet*, and in all respects as in the *Viper*. From the *Pylorus*, the *Ductus* streightned again for $\frac{1}{2}$ Inch, and then formed a large Intestine, which afforded a pleasant Sight, by the weaved *Rugæ* of its inward Coat, which Gut, after some small Windings, ended at last in the *Rectum*, whose Capacity was much less than the former. In the Stomach and Guts, I observed abundance of *lumbrici Tertes*, which is a Disease *Vipers* likewise are subject to. I take the Swellings in the *Gullet* to perform the same use in these Animals as the *Crop* in Birds and the *Paunch* in *Quadrupeds*; they being convenient Receptacles for retaining what Food the Stomach cannot yet well receive; and here it seems the more requisite, since they feed but at one time of the Year. And since in that promiscuous Food they take in, which they swallow always whole, there are often some Parts unfit to be digested, and therefore to be returned again, the *Gullet* here being very long, and upon that Account incommodious for this Action; Nature has provided these Swellings in it, where it may be respited, till recruiting its Force, it gives them another Lift, and upon a third Effort, at last wholly ejects them. And if what is confidently reported by many be true, that on Occasion of Danger, they receive their Young into their Mouths, these are fit Places for Receiving them.

The Food before it can prpve *Aliment*, must be comminuted, and broken into the smallest Particles, which in these membranous Stomachs, I cannot see how it can be performed, but by Corrosion. A principal Menstruum in doing this, I take to be that Liquor, which is discharged by the Glands that are seated some at the Beginning of the *Tbroat*, and are called *Salivæ*, or just above the Stomach or Gizzard of Birds, and called the *Echinus*, or in others in the Stomach it self, and called the *Glandulous Coat*, and such I take the inward Coat of the *Stomach* of our *Rattle snake* to be. When

Comminuted 'tis discharged into the *Guts*, which, that the *Chyle* might not pass off with the *Fæces*, are often *Convolutèd*, or *Winding*, as here : that so by impeding a too quick *Descent* of it this Way, or by *Valves*, a Separation may the better be made ; and then the *Fæces*, as uselefs, cannot quicker be discharged than by the *Rectum* ; which where the *Fæces* are hard, is furnished with a stronger *Muscle*, the better to help its *Action* ; and such seem'd the *Rectum* here, and the *Fæces* harder than usual in *Vipers*. Fig. 205. c.

The *Heart* was placed near the bottom of the *Trachæa*, on the Right side of it. The Length of it was $1 \frac{1}{2}$ *Inch*, its Figure rather flat than round ; encompassed with a *Pericardium*, and the *Auricle* larger than the *Heart* itself. It hath but one *Ventricle*, the *Valves* small and fleshy, and the inside of the *Ventricle* distinguish'd by 4 or 5 cross Furrows. Why *Charas* should make the *Heart* of the *Viper* to have two *Ventricles*, I see no reason : I should much more easily allow a double *Auricle*, one at the Entrance of the *Vena Cava*, of which there are two Branches descending, and one ascending ; the other for the *Arteria Aorta*, which has two ascending and one descending. Fig. 205. d.

A little below the *Heart* lies the *Liver*, which was about an *Inch* wide, in the largest Place ; and seem'd divided on one side by the *Vena Cava* into 2 *Lobes* of an unequal length, for that on the left Side was about 10 *Inches*, and that on the right Side about a Foot long. Its Colour was a brown red, and its use, no doubt, for the separating the *Gall* that was contained in a *Bladder* seated at some Distance below it. This *Gall-Bladder* was two *Inches* long, the Colour of the *Gall* contained in it a *Grass-green*, which sweating through its Coats, had deeply tinged all the adjacent Parts ; the Taste of it, in a *Viper*, which seems the same, for I did not taste it here, was first salt, then a sweet-bitter. The *Ductus* which brings it from the *Liver*, is obscure, and hard to be found : But the *Ductus Cysticus*, by which it empties it self into the *Intestine*, is evident enough. It arises from the top of the *Bladder* ; so gently descending, passes thro' that part which *Charas* takes for the *Pancreas*, but which the *Ancients* call'd the *Spleen*, and so enters the beginning of the larger *Intestine*. In *Vipers* indeed, the Colour of this Part, and Situation so near the *Intestine*, seems an Argument for *Charas* his Conjecture ; but here its Colour, which was deep red, and such hitherto I have observed the *Pancreas* to be in no other Animal, as likewise its Figure, not spreading, but more compact, seem to favour the Opinion of the *Ancients*. I have only this to say of it, that it was about the bigness of a large *Bean*, that it adhered to the Side of the *Intestine* at the beginning of it, and that through the middle of it, as is already observed, the *Ductus Biliaris* did pass. Fig. 205. e.

The *Fat*, which was very plentiful, is said to be used by the Physicians of *Mexico* with good Success in the *Sciatica*, and all Pains of the *Limbs*, and for discussing *Preternatural Tumours*. The *Membrane* it adhered to I take for the *Omentum*, which encompassed all Parts contained in this lower Belly ; Fig. 205. f.

and was joined to both sides of the *Ribs*, so running to the *Rectum*, and forming a Bag that inveloped the Parts here, but was free and not conjoined towards the *Belly*. The lower Belly I call it, to distinguish it from the rest of the Trunk, for the whole was but one continued *Cavity*, there being no Partition of it by any *Diaphragm*.

Fig. 26.

The *two Kidneys* which lay to the Back on each side of the *Spine*, but not very firmly conjoined, were about 7 *Inches* long, that on the right side something longer than the left, and about $\frac{1}{2}$ *Inch* broad each; And though the Substance of it seems one continued Body, yet it is plainly distinguishable into several lesser *Kidneys*, for they ought to be reckoned as many as there are distinct Systems and Orders of *Vessels*, which according to the Advantage of the Body of this *Animal*, are placed at length, not piled on one another. As I remember, in one of the *Kidneys* I numbred 25, all very curiously contrived, and with an inexpressible Beauty. When they were first taken out of the Body, the whole seemed a delicate Compages of *Vessels*, and the Intermixture of those of the Blood, with those other white ones, that are the *Secretory*, composed most regularly formed Bodies. In the Figure, that on the left side represents the upper Superficies of the *Kidney*, which appears first in the *Dissection*; the other, the lower side which lies to the Back; in both there are two large Blood *Vessels* running down each side, one marked *nnn*, the other, where the *Vas deferens* runs, but is not here represented, and from these arise several lesser Branches, *ooo* at set Branches, which curiously spreading themselves do form, as it were, *Ramifications* of Trees. As many as there were of these emulgent *Vessels* (for so I take them to be) so many *Kidneys* were in each; the Interstices *ppp* of these Blood *Vessels*, were filled up with other white ones, which I doubt not are for the *Secretion* of the *Urine*, and on this side did appear more numerous than on the other. But 'tis impossible to represent the curious Interweavings of both; but here in the under-side of the right *Kidney*, in some places they appeared more distinct; for *QQ* shews the large *Blood Vessel*, whence arise the *Emulgents*, *rrr* which spreading themselves very thick into the Bodies *sss* make them appear all bloody; between which for a little Space, there appears a small Body of the *white Secretory Vessels*, *ttt*. The use of this Part, in all *Animals*, is for carrying off the *Lixivial* and superfluous *Serum* of the Blood, which is of so great Consequence, that even those *Animals* that drink not at all, or but very little, yet by Nature are furnished with them; as the *Rattle Snake* may be thought. When the Separation of this Humour is made in the *Kidneys*, 'tis conveyed thence by the *Ureters* into a Bladder, if the too frequent Exclusion of it might be inconvenient to the *Animal*; or, if it be made in lesser Quantity into a *Cloaca*, just at the *Anus*, and so to be rejected.

Fig. 206. 210

The *Ureters* did run almost the Length of the *Kidneys*, being a common Trunk that received the lesser Branches, that went to each single Gland, and did terminate near each other in the *Cloaca*, making a Riling there;

there ; for our *Rattle Snake*, like *Birds*, had a *Cloaca*, which in the Female *Viper*, receives the Orifices of the *Ureters*, and the two *Uteri*, and in part may be said that of the *Rectum* too, which had a *Connivent Valve* that covered it.

Near the Verge of the *Cloaca*, we observed two other Orifices, which seemed covered by the folding of the Skin, and these led into those two *Bags* which I have taken the Liberty to call the *Scent Bags* : One of them was about an Inch long, and as big as a Goose-Quill, but taper towards the End, and from the Colour of the Liquor it contained, appeared darkish : The other *Bag* was something less, and its Colour as in the *Viper* ; this Difference, I suppose, may be accidental. The *Liquor* included in them was something crass, and of a strong and very unpleasant Smell ; such, but in a more intense Degree, as the Animal did emit before Dissection. Fig. 206. mm

I shall here add, that our *Common Snake* emits a far greater *Fætor* (which lies in the same *Bags*) than our *Adders* or *Vipers* : And I have been told by Travellers, that some *Crocodiles* will leave a strong but grateful Smell behind them, which, if so, I doubt not but it may be upon the same Cause.

But usually, tho' this *Liquor* when new, and in great quantity, be offensive and of an ill Smell, (and such is *Civet* likewise, which is nothing else) yet when dry, and in lesser Proportions, it may prove more grateful.

Thus the *Liquor* in the *Scent Bags* of a *Weasel* being dried on a Paper, and kept some time, did not seem unpleasant to me ; but rather the contrary : And I see no Reason why *Pole-Cats* may not be *Civet-Cats*, though they may not turn to that Account. But in a *Lyon* I dissected, the *Liquor* contained in the *Scent-Bags* was, in the Opinion of all that smelt it, much like that of Oil of *Anise*, or *Fennel-Seed* ; which was almost the only Difference I could find between the *Lyon* and a *Cat* ; for in a *Cat* this *Liquor* is ill Scented.

The *Testes* are very unproportionate in Length, the Right being $2\frac{1}{4}$ Inches long, the Left $1\frac{1}{2}$ Inch long, scarce so big in Compass as a Goose Quill. The unequal length of this Part *Charas* takes notice of in *Vipers* ; and I shall add, that the *Ovarium* of the Female *Viper* is the same ; for that of one side was as big again as the other. The Colour of the *Testes* was White, as is usual, and so was their Substance. The *Vasa Præparantia* had nothing uncommon : But the *Deferentia* were remarkable, for though they did run in a straight Line almost from the *Testes* to the *Penis*, and did form no large Body, yet this *Ductus* was so often involuted, that were it unravelled and extended its whole length, 'twould be twice as long ; which made me think that it was only the Extension of the *Epididymis* ; for the whole *Testes* is but a Congeries of curiously convoluted Vessels which terminate in the *Epididymis*, whose Continuation makes the *Deferens*. And where its *Convolution*s are many upon the Body of the *Testes* it self, there the *Deferens* is an even *Ductus* : But as in our Subject it making no such Body Fig. 206. ii

Fig. 207. a

there or but a very small one, in its Passage downwards it was every where crimped, and about the middle of the *Kidneys* often convoluted. Upon the Dissection of a *Viper*, I have since found that they were continued along the *Penis*, single where the *Penis* was so, and afterwards divided, and did run to the end of each: Nor were there any *Vesiculae Seminales* or *Prostates* here to receive them.

Fig. 206. k.

There were four *Penes*, two on each side, which lay sheathed in the Body: so that upon first opening it they were not perceived, but only the large *Orifices*; where they were drawn in as a Finger of a Glove may be by a Thread fastned to the end. But having protruded them by a *Probe*, they appeared as is represented in the Figure. And I did observe that towards the *Basis*, or Root they were single of each side, and that here they were thick beset with Prickles, whose Points looked backwards, and were very sharp and seem'd, especially when dry, like the Substance of the bristles of a *Hedge-Hog*: but hence they were divided, and did form two round Bodies of the bigness of a small Goose-Quill, about $\frac{1}{4}$ of an Inch long, of a red Colour, but the whole, as protruded, was above an Inch long. When protruded, I found they could be easily retracted, and drawn in by the help of large Muscles, that were fastned to them and did run along under, and were at last inserted at the end of the Tail, at the setting on of the first *Rattle*; which upon the Trial was so plain that we need not doubt of the use of them, and I shall therefore call them *Retractores Penum*. There are several Animals that have no *Penis* at all, but *Vasa Deferentia*, as most Fishes. All *Quadrupeds* that I know of have but a single one. Some *Birds* have but one. Most others, if they may be said to have any, have two, but very short. In *Crabs*, *Lobsters*, &c. there are two long ones, one on each side: but *Earth-worms*, *Leeches*, *Shell snails*, &c. are *Hermaphrodites*, and have the perfect Organs of both Sexes. But where the Sex is single, the *Rattle-snake* and that Family have these Organs of Generation the most numerous of any I have hitherto met with. But why the *Male Rattle Snake*, or the *Male Viper*, should have four *Penes*, when the *Female* has but two *Uteri* for receiving them, seems a difficulty to me. Amongst many Conjectures I have had about it, what seems the most to satisfy me, is this: That they have the *Penis* here on each side double, or Forked, that so being entered the *Uteri*, by spreading themselves like the *Pythagorean Y*. they may the better and more firmly be retained there till they have performed their Duty. And this too seems one use of the *Aculei* or *Bristles*, towards the Root of them; for having their Points looking backwards when once they have entred the *Pudendum*, they must needs lock them in, and retain them there, till such time as the parts being tired and subsiding, have leave to retreat. For in *Animals* that have no *Vesiculae Seminales*, 'tis requisite that the *Coitus* be long, that so the Seed which cannot quickly, may leisurely be transmitted from the *Testes*; but where 'tis before, hand stored up in the *Vesiculae*, there the *Coitus* is soon over; but when they must expect the *Generation*, or at least a sluggish Descent of it, Nature makes Provision for the more convenient performing it. So in *Dogs*, which have no

Vesicula

Vesiculæ Seminales, near the Root of the bony Penis there is a large Body made up of an abundance of Cells and Vessels : which, upon the rushing in of the Blood and Spirits, is so mightily extended and swelled, that it forceably keeps him in, till such time as the *Impetus* be over, and the part subsides. So the *Lump-fish* on it's Breast has a large round Body curiously contrived, like the Tail of a *Leech*, or the *Acetabulum* of the *Polypus*, by which it can firmly adhere to the Females, and so by this means, tho' its Penis be very short, yet be able to perform a *Coitus*. *Cats*, *Lyons*, &c. which have likewise very short Penes, that they may the better cling, are forced to make use of their Teeth and Claws, and from the Pain of these, not from the scalding of the Seed, come those fierce Shrieks and hideous Yowlings. Therefore in our *Rattle Snake*, (where, as we have observed, there are no *Vesiculæ* and where the *Vas Deferens* is all along crimped and winding : and so upon both Accounts must be thought to be long in *Coition*) the Contrivance and Structure of these Parts seem very requisite. For although in this Action they twist their Body, which may be some Advantage too, yet not sufficient alone : for otherwise upon a little occasion the Parts would be apt to slip out, which now they cannot, being Forked and Hooked in too by the *Aculei* or *Bristles*. But the *Deferentia* being continued to the end of the Penis do likewise shew this must be the use of them. But that the Female may receive no Injury by these *Spines*, Nature has made that Part of the *Uteri* which they enter, strong and gristly ; as we observed in a *Viper* ; and that the Male too might not be harmed by an over Extention of these Parts, those strong *Muscles*, which serve for Retracting and Drawing them in, do likewise secure them in this respect too. It may be likewise considered, since they are naturally so cold and *Frigid*, whether these *Aculei* may not serve to incite them, and stir them up.

The Head was but small, yet the *Rectus* was very large. The Tongue, Fig. 209. g. in all respects like that of a *Viper*, was composed of 2 long round Bodies, contiguous and joyned together from the Root $\frac{2}{3}$ of its length, with great Agility they could dart them out, and retract them again ; and that part which appeared out was of a black Colour, whereas that which lay sheathed within was red ; for 'twas fastened below the Throat, and thence was covered with a *Vagina* or Sheath to the place where it issues out, which was near to the end of the *Larynx* ; and for the better Ejaculation of it, the under Jaw too was here divided, leaving a considerable space.

For if it were conjoyned as in other Animals, and beset with *Teeth*, they would be apt to injure the *Tongue* ; or at least it might prove incommo- Fig. 209. i. dious to the use 'tis designed for, which in part I suspect with *Charas* to be for catching Flies, and such small Creatures they have a mind to devour.

Over the *Tongue* did lie the *Larynx* ; not formed with that Variety of Fig. 209. f *Cartilages* as is usual in other Animals, but so as to make a Ruine or Slit, for Receiving or Conveying out the Air. Nor was there any *Epiglottis* for preventing

preventing other Bodies from slipping in; this being sufficiently provided for, by the strict Closure of them: And the Air passing only through such a slit, without the Contrivance of other Parts for modulating it, can only make such a Sound as we observe in their Hissing.

Fig. 209. *ech*
Fig. 209. *d d*
Fig. 210. *b*
Fig. 211.

Fig. 210. *g*
Fig. 210. *f*

The *Teeth* are of two sorts. 1. The Lesser which are seated in each Jaw, and serve for the Catching and Retaining the Food. 2. The Poysonous Fangs which kill it, and are placed without the upper Jaw. They are all *Canini* or *Apprehensores*: For since they do not chew or bruise their Food, but swallow all whole as they meet with it, there is no need of *Molares*. Of the first sort of *Teeth*, in the lower Jaw there are two Rows on each side; five in a Row, the inner lesser than the outward, so that that there are here twenty in all. In the upper Jaw are but sixteen, five on each side placed backwards, and six before: these do no harm. The Fangs are placed without the upper Jaws, towards the fore part of the Mouth, not fastened to the *Maxilla*, as the other *Teeth*: but the two outmost and largest Fangs were fixt to that Bone, which, if any, may be thought to be the *Ear-bone*. The other Fangs I could not perceive were fastened to any *Bone*, but to *Muscles* or *Tendons* there. These Fangs, or larger *Teeth*, were not to be perceived upon first opening the Mouth, they lying couched under a strong Membrane or Sheath; but so as did make a large Rising there on the outside of the lesser *Teeth* of the *Maxilla*, but at pleasure when alive they could raise them to do Execution with; not unlike as a Lyon or a Cat does its Claw. These *Teeth* were hooked and bent like the *Teeth* of a *Barbarossa*: but some of the smaller of them were bent at *Right Angles*. On each side we met with about six or seven, but not placed altogether so exactly as in the Scheme. In all these *Teeth*, especially the larger, we took notice of a pretty large *Foramen*, or hole towards the Root of it, and towards the Point there was a plain visible and large Slit, like the cut of a Pen sloping; and that part from the Slit to the Root was perfectly hollow: which first of all was discovered to us, by pressing gently with our Finger the side of the *Gum*; for then we did perceive that the Poyson did readily arise through the Hollow of the *Teeth*, and issued out of the Slit.

This Poysonous Liquor I observed to be of a *Water Colour* lightly tinged Yellow. What the Poyson of Serpents is, and how it produces its dire Effects, has been of late contested between S. *Redi* & M. *Charas*. 'Tis *Redi's* Opinion, that the yellow Liquor contained in the *Vesicles* of the *Gums* of *Vipers*, is the only and true Seat of the Poyson; that this Juice is not *Venemous*, when taken in at the Mouth; but that it is so when let into Wounds, whether it be used when liquid, or after it is dried. But M. *Charas* wholly opposes this, and asserts, that the Poyson is no where but in her *irraged Spirits*; and that this Yellow Juice is nothing but a meer *innocent Saliva*.

But the Fabrick of the *Teeth*, (they being thus Hollow, and having that large slit towards the end, and this Juice so readily and naturally issuing through them) seems to me to argue, that Nature designs it for other uses than

than Nourishment ; for if so, by giving them so large a Vent she would be frustrated of her end. But they being so sharp and strong at the Ends, and the Slit too placed towards the back, not inside of the *Tooth* ; what can be more conveniently contrived both for making the Wound, and infusing the Poison ? For if the Slit was inwards, by the struggling and withdrawing of the *Animal* assaulted, the Slit would be apt to be stoppt and occluded ; and the descent of the Poison prevented : But being thus formed, it gives a greater Advantage for its *Infusion*. Thus the *Scorpion*, the *Bee*, the *Emmet*, nay the *Sting* of a *Nettle*, at the same time they make a Wound, they leave behind them a drop of Liquor, which excites those dreadful *Symptoms* : Whereas the Wound without it, would be inconsiderable. And what has some Weight with me (contrary to the Sentiments of M. *Charas* of the Innocence of this Liquor) is a Relation I had from an intelligent and knowing Person, who informed me that being in the *Indies*, there came to him and his Company an *Indian* with several sorts of Serpents, and offered to shew them some Experiments about the force of their Poyson, and the difference of them ; and that this Practice is common with them. Having therefore pull'd out a large one, the *Indian* told him that this would do no harm ; therefore making a *Ligature* on his Arm, as they do in *Letting Blood*, he exposed it naked to the Serpent, having first whipt and irritated him to make him bite it. The Blood that came out of the Wounds, made by his *Teeth*, he gathered with his Finger, and laid it on his naked Thigh till he had got near a Spoonful. After this he takes out another call'd *Cobras de Cabelo*, which was lesser, and enlarges much upon the greatness of its Poyson ; and to shew them in part an Instance of it, grasping it about the Neck, he expresses out some of the Liquor in the *Baggs* of the *Gums* about the quantity, as he thought of $\frac{1}{2}$ a Grain, and this he puts to the Coagulated Blood on his Thigh ; which as soon as mixt with it streight put it into a great Fermentation, and Working like *Barm* changed it into a Yellowish Liquor. The same has been likewise observed by others, and does seem to give us some Light, how 'tis that this Poyson acts, and confirms the known Observation, that the biting of a *Viper* will cause the *Yellow Jaundice*. A present Antidote for this Poison is said to be the Snake Stone ; *Pierre de Cobras de Cabelo*, 'tis call'd by the *Portuguese*, and is famous all over the *Indies* ; 'tis described by *Garcias ab Horto*, by *Kircher* and others, particularly by Senior *Redi* who renders very much suspected the Relations that are commonly had of its great Force and Vertue : But that it does not always fail, some Accounts I have had of Persons relieved by it here in *England* have convinc'd me. One instance is remarkable that was told me by an Eminent Physician in *London*, of a Person near the Town that was bit by a *Viper* ; his Hand and Arm soon swelled with great Extremity of Pain : But upon the Application of this Stone for one Night both were asswaged, and he thought himself well, and took off the Stone, which did still firmly adhere. But not long after his former *Symptoms* violently returning, he had recourse to his *Antidote*, and then suffered it to continue there till it fell off it self, and

and so was cured. One Tryal I formerly made my self, in a Patient troubled with the *Gout* in her *Stomach*; having removed it thence, it seiz'd her *Toe*; but she being impatient of the Pain, that I might seem to do something, and to hinder her using abundance of Medicines, which every Body was like to advise her to, and might be apt to strike it to her *Stomach* again, I thought of this; holding the Stone therefore in my Hand, and without acquainting her, I put it near the Joynt where her Pain was most; and being very near it, I perceived it move out of my Hand, and readily adhere to the Part. Soon after she acquainted me, that she very sensibly perceived a great drawing and trickling all down her Leg and Thigh, and afterwards owned an Abatement of her Pain. In *Pestilential Swellings* very probably it may be of use.

- Fig. 210. a. Amongst the Bones of the Head, I observed that the *Cranium* here was entire, and without Sutures: only where some other Bones were joyned to them; as forwards over the Nostrils were two small Bones, to which were fastened the *Cartilages*, or rather *Bones* which divide the *Nose*. The other Bones seemed admirably contrived for the great Extension, and widening of the *Maxilla*: Which seems a great Provision of Nature; for since it must swallow all things whole, and its Head is but small, without this most *Mechanical* Contrivance it were impossible to do it. The upper Jaw forward was joyned to the Bone that receives the Poisonous Fangs; and which had a large Cavity in it, which opened outward, and was thought to be the *Foramen* of the *Ear*: but inwards we observed no Perforation for a *Nerve*, unless there might be one that comes to it under that bone which conjoyns it to the *Cranium*. This *Articulation* seems advantageous, both for the Motion of the Fangs, which lie sometimes couched, sometimes erected, as of the Jaw too: but its principal and most remarkable Advantage for swallowing large Bodies, is the curious *Articulation* of the *Maxilla* backwards to the *Cranium* by 2 bones, which from their use (since we know no Name to distinguish them by) we shall call *Maxillarum Dilatores*. Their shape, bigness and aptness for this Motion will readily enough be conceived by the Eye in observing the Figure. For the lower Jaw being not conjoyned at the *Mentum*, as is usual in other Animals, but parted at a good Distance; upon the receiving a large Body, as the *Membrane* here to which they are fastened easily extends, so by lifting up, as also by bringing these 2 bones more to a straight Line, it must needs considerably widen the *Rictus* of the Mouth: and for this Cause too they are made two, not one, for performing this Motion more easily. This *Articulation* of the *Dilatores*, which is very curious, with the upper and lower Jaw, makes those *Protuberances* of the Head, which we likened to that of a Bearded Arrow. The lower Jaw of each side was composed of two bones, as appears in the Figure, but firmly conjoyned. The Fore bone was for receiving the small Teeth, the hinder towards the *Articulation* grew broad; as likewise did the bone of the upper Jaw answerable to this place in the lower. But this upper Jaw, towards the Poisonous Fang, divided into two Bones; one was fastned to the Bone of the
- Fig. 209. b.
- Fig. 210. c. c
- Fig. 210. n.
- Fig. 210. m.
- Fig. 210. k k
- Fig. 210. i

Poisonous

Poisonous Fang outwards; the other, which received the small *Teeth*, was inserted into the same *Bone* more inwards.

The *Vertebrae*, according to the whole Figure of the Body, were smallest towards both Extreams, and largest in the middle. From the Neck to the *Anus* there were as many observed as *Scales* on the *Belly*, viz. 163. but from the *Anus* to the setting on of the *Rattle*, 29 more in Number than the *Scales*.

The former *Vertebrae* had a flat upright Spine towards the Back; and a slender round Oblique descending one inwards to the Belly. To each *Vertebrae*, besides those Spines just mentioned, there were other *Processus's* for the advantage of setting on the Ribs, and the *Articulation* with one another: But, what was most remarkable, the round Ball in the lower Part of the upper *Vertebra*, which enters a Socket of the upper part of the lower *Vertebra*, like as the Head of the *Os Femoris* does the *Acetabulum* of the *Os Ischii*; by which Contrivance, as also the *Articulation* with one another, they have that free Motion of Winding their Bodies any ways. The Ribs in the Neck were small, but larger towards the middle of the Body, where they were about 2 Inches long; but towards the Tail they grew lesser and shorter again; and did all terminate at the beginning of the *Scales* of the Belly. In the *Vertebrae* of the Tail inwards there were 2 Spines: Whereas, in the other *Vertebrae* there was but one; as likewise there were here Transverse slender *Processus's*, something Analogous to Ribs.

To the last *Vertebra* of the Tail was fastened the *Rattle*; in our Subject there was but five, but some others seemed to be broken off. That next the Tail was of a Lead Colour, the others of a Cineritious. 'Tis well described by Dr. Grew, in his *Musæum Reg. Soc.* This *Rattle*, according to *Gulielm. Piso* (and I know no other use of it) was given by Nature to this pernicious Animal, *ut illius Sonitu admonitus quilibet Homo non solum, sed & quaecunque pecus, vel Jumentum, tempestive sibi carbeat a vicino Hoste.* Some Authors assert, that every Year there is an Addition of a new *Rattle*; which Dr. Grew suspects, for then he must live 16 Years; for so many Joyns there are observed in some in our Repository; I have been told, in some there have been above 20. These *Rattles* are placed with their broadest Part perpendicular to the Body, not Horizontal. And the first is fastened to the last *Vertebra* of the Tail by means of a thick *Muscle* under it; and by the *Membranes* that conjoin it to the Skin.

Fig. 205. Represents the upper part of the Body opened, *aaa*. The *Aspera Arteria*, *B*. The upper part of the Lungs, which is *vesiculous cccccc*. The lower Part of the Lungs, which makes a large Bladder, *d*. The first Swelling of the *Oesophagus*, or *False Stomach*, *eee*. The *Oesophagus*, or Gullet, and that part of it where 'tis streighter, *f*. The Second Swelling of the *Oesophagus*, or Second *False Stomach*, *g*. The *True Stomach*, *b*. A short streightning of the Gut, a little below the *Pylorus*, *i*. The *Intestine*, *k*. The Heart, *l*. The *Auricle*, *mm*. Three Arteries, whereof there are two *Ascending*, and one *Descending*, *nnn*. Three large *Veins*, whereof two are *Descending*, and the third *Ascending*.

Ascending ; which last does seem to divide the *Liver* into two *Lobes*, *o o*. The *Liver*, *p*. The *Gall Bladder*, *q*. The *Spleen*, as 'tis call'd by the *Ancients* ; but by *Charas*, the *Pancreas*, *r r r*. A large *Blood-Vessel* that runs in the midst of the *Scales* of the *Belly*, *s s*. The *Muscles* belonging to the *Scales* of the *Belly*.

Fig. 206. The Parts contained in the lower Part of the Body, *a a a*. The *Intestines*, *b*. The *Gall Bladder*, *c*. The *Ductus Biliaris*, that passes thro' the middle of the *Spleen*, or as called by *Charas*, the *Pancreas*, and enters the large *Gut*, *d*. The *Spleen*, or *Pancreas*, *ee*. The *Intestines*, which were very large and winding, but short, *ff*. The *Rectum*, *g*. The *Anus*, *bb*. The *Testes*, *ii, ii*. The *Vasa Deferentia*, *kk*. The *Penes* on each side, which first at the Root are conjoyned and are thick beset with *Bristles*, *ll*. The *Muscles* that serve for the drawing in the *Penes*, *mm*. The *Scent-bags*, *nn*. A large *Blood-vessel* that runs on one side of the *Left Kidney*, *o o*. The *Emulgents* that arise from the same, *pp*. The *Secretory Vessels*, *Q Q*. The large *Blood-vessels* of the right *Kidney*, *r r r*. The *Emulgents* arising from it, *s s s*. A round Body of *Blood Vessels*, *ttt*. *Secretory Vessels*, *u u*. The *Ureters*.

Fig. 207. The *Penes* of one side of a *Viper*, *a*. The *Vas Deferens*, which afterwards divides, and runs to the end of the *Penes* *b*. The *Penes* *c*. The *Muscle* which retracts the *Penes*.

Fig. 208. The *Lungs* opened by the *Trachea*, *a a a a*. The *Arteria aspera*, divided in the middle, *bb b*. Some larger Branches of *blood Vessels* *c c c*. The *Vesiculæ*, or *Cells* of the *Lungs*.

Fig. 209. The *Head*, with its *Mouth* open'd, *a*. the hole of the *Nostril*, *b*. the *Foramen* which leads to a large *Cavity*, which has no *Perforation* for any *Nerve* inward, but yet 'tis thought to be for *Hearing*, *cc*. the small *Teeth* in the upper *Jaw*, *dd*. the large *Fangs*, or *Poysonous Teeth*, *eee*. the Place where the *Bladders* of *Poison* lie, *f*. the *Larynx*, *g*. the *Forked Tongue*, *h*. the *Teeth* in the lower *Jaw*, *i*. the place where the lower *Jaw* is divided at the *Mentum*.

Fig. 210. The *Skull*, *a*. the *Cranium*, without any *Sutures*, *b b*. the *Orbits* of the *Eyes* *c c*, two small *Bones* over the *Nose*, *d*. the *Gristly*, or rather *Bony Sepimentum* of the *Nose*, *e e*. A small *Bone*, that lies between the *Cranium* and that *Bone* in which is fixed the *Poisonous Fangs*, *ff*. A *Cavity* in that *Bone*, to which is fastened the *poisonous Fang*, whose outward *Orifice* is represented in Fig. 209. by the Letter *b*. and is thought to be the *Ear*, *g*. the large *Poisonous Fang*, which is fastened to the *Ear-bone*, *b*. the other *Poisonous Teeth*, which are not fixt in the *Bone*, but to *Muscles*, *ii*. the upper *Maxilla*, which contains the small *Teeth*, *k k*. One side of the lower *Maxilla*, with its double Row of *Teeth*, which in the middle seems to be joyned by a *Suture*, *l*. the Distance at the *Mentum*, between the two sides of the lower *Maxilla*, or *Jaw*, *mm*. Where the two *Maxilla* are joyned together backwards, and by a *Tendon* are fastened to another *Bone*, which from its use, and for *Distinctions* sake, we call *Dilatores Maxillarum*, *nn*. the *Dilatores* of the *Jaws*, *o o*. A short *Bone* which joyns the *Dilatores* to the *Skull*, or *Cranium*, *p*. the *Vertebræ* of the *Neck*.

Fig. 211. The Poisonous Teeth.

Fig. 212. One of the *Vertebrae* of the Back, *a.* the outward Spine of the *Vertebrae*, which is flat longways, *b.* the inward Spine of the *Vertebrae* which is round, *c.* A large flat *Processus*, for the Articulation of the *Vertebrae*, *d.* small *Transverse Processus's* for the setting on the Ribs, *e.* A round Ball, like the Head of the *Os Femoris*, which enters a Socket of the lower *Vertebrae*, as that does the *Acetabulum* of the *Os Ischii*.

Fig. 213. One of the *Vertebrae* of the Tail, *a.* the Spine towards the Back, *b b.* the two inward Spines, *cc.* the Transverse Spines, Analogous to Ribs.

Fig. 214. The *Vertebrae* of the Tail, and the *musculous Flesh*, which fastens the first Rattle, *a.* the *Vertebrae*, *b.* the *Muscle* on which is fastened the Rattle.

Fig. 215. A Single Rattle, which has three Joynts : the first and largest appears when conjoyned with others, the two other serve for the fastening on the succeeding Rattles, and are covered by them.

Fig. 216. The Five Rattles, as joyned together.

XLIV. The *Wild penny-royal* or *Dittany* of *Virginia*, groweth straight up about one Foot high, with the Leaves like *Penny-royal*, with little blue Tufts at the joyning of the Branches to the Plant, the Colour of the Leaves being a reddish-green ; but the *Water distill'd*, of the Colour of Brandy, of a fair Yellow : The Leaves of it bruised are very hot and biting upon the Tongue. Of these Leaves so bruised we took some, and having tyed them in the Cleft of a long Stick, we held them to the Nose of the Rattle Snake, who by turning and wriggling laboured as much as she could to avoid it : But she was kill'd with it, in less than half an Hour's time ; and, as was supposed, by the Scent thereof. This was done *A.* 1657. in July, at which Season those Creatures are reputed to be in the greatest Vigour for their Poison. It is also remarkable that in those Places where the *Wild Penny-royal*, or *Dittany* grows, no Rattle-Snakes are observed to come.

XLV. There is this Difference between the Brooding of Snakes and Vipers ; the Snakes lay their Eggs on Dung-hills, by whose Warmth they are hatched : but the Viper brood lay their Eggs within their Bellies, and bring forth Live Vipers. To which may be added, that some affirm to have seen Snakes lie upon their Eggs, as Hens sit upon theirs.

XLVI. In order to examine the Opinions of *M. de la Chambre*, *S. Redi*, and others, concerning the Poison of Vipers, *Dr. Francini* came to the House of *S. Magalotti* 2 Jun. 1672. and sent for a Box, in which were a great many Heads, cut off that Morning, of Vipers lately come from *Naples*. *S. Magalotti* also sent to the publick Market for a couple of Pigeons, to be sure of having some that were not prevented by any Antidote. The Pigeons being

ing come, the first was wounded with the Teeth of a *Viper's* Head that had been cut off about 7 or 8 a Clock the same Morning. The way of making the Wound, was by thrusting twice the *Master Teeth* into the fleshy Part of the Pigeon's Breast, till such time as pressing the upper part of the Jaw, the two little Bladders, hat serve as Gums to the Teeth, did empty out upon the Wound some of that *Yellow Liquor* which here is supposed to be the true and only Poyson of the *Vip. r.* This Pigeon being thus bit, and set upon the Ground, began to stagger immediately, and died in less than 3 or 4 Minutes. The second Pigeon was wounded in the same manner; but at the first Wound there only entred one of the Teeth, which brought forth a great deal of Blood; the second time they both entred, and this had the same Fate, with this Difference only, that he languish dhalfe a quarter of an Hour.

The next Morning 6 Pigeons and a Cock having been brought, Dr. *Francini* at first thrust several *Thorns* of *Rose Shrubs* into the Breast of one of those Pigeons, to manifest, that such Accidents as might befall those that should be wounded by the Teeth of Dead *Vipers* were not merely caused by the Wound; and afterwards for the further Satisfaction of the Company, he took a Pin, which was none of the least, and gave another Pigeon a very deep Wound in the Breast, which was no sooner got free, but began to leap and frisk about the Room, as if it had not been concerned in the least. Then a third Pigeon was bit in the Breast by both the *Master-Teeth* of a *Viper's* Head, that had been cut off the Morning before; the Effect was, that the Pigeon had the same shaking Fits; after which, falling upon his Belly, in 5 or 6 Minutes after the Wound, he died; giving Signs a little before of a painful Agony, by its often Gaping. Another having been served after the same manner with another Head, had the like Accidents, and died within a quarter of an Hour. It was also observed that the Wound of this last Pigeon let out a great deal of Blood, whereas not so much as one Drop was seen to come out of any of the others.

After the Experiments, the Doctor took three Stalks out of a Broom, and having smooth'd them, and sharpened them at the ends after the manner of a *Lancet*, he drew from the Gums of several Heads enough of that yellow Juice to dawb two of those Stalks; which, being thus moistened with that Liquor, were both put into the breasts of two Pigeons, and there left; the like having been done to another with the third Stalk not covered with that Juice, which was at least one third part bigger and longer than the other two. In a Word, the two first died within 4 or 5 Minutes, and the last was in *August* following in *S. Magalotti's* Pigeon-House, as brisk and fat as ever though the Stalk was not drawn out till after some Days.

Upon a Relation, that some had asserted at *Paris*, that to swallow a *Viper's* Head, was a most certain Preservative and Remedy against the biting of a *Vip. r.*; Dr. *Francini* made these two Experiments. He made the Cock swallow a *Viper's* Head, and then caused him to be well bitten in both Thighs by a Live one. The other Experiment was by thrusting the Teeth of a dead *Viper's* Head into another Pigeon, that had before got down on

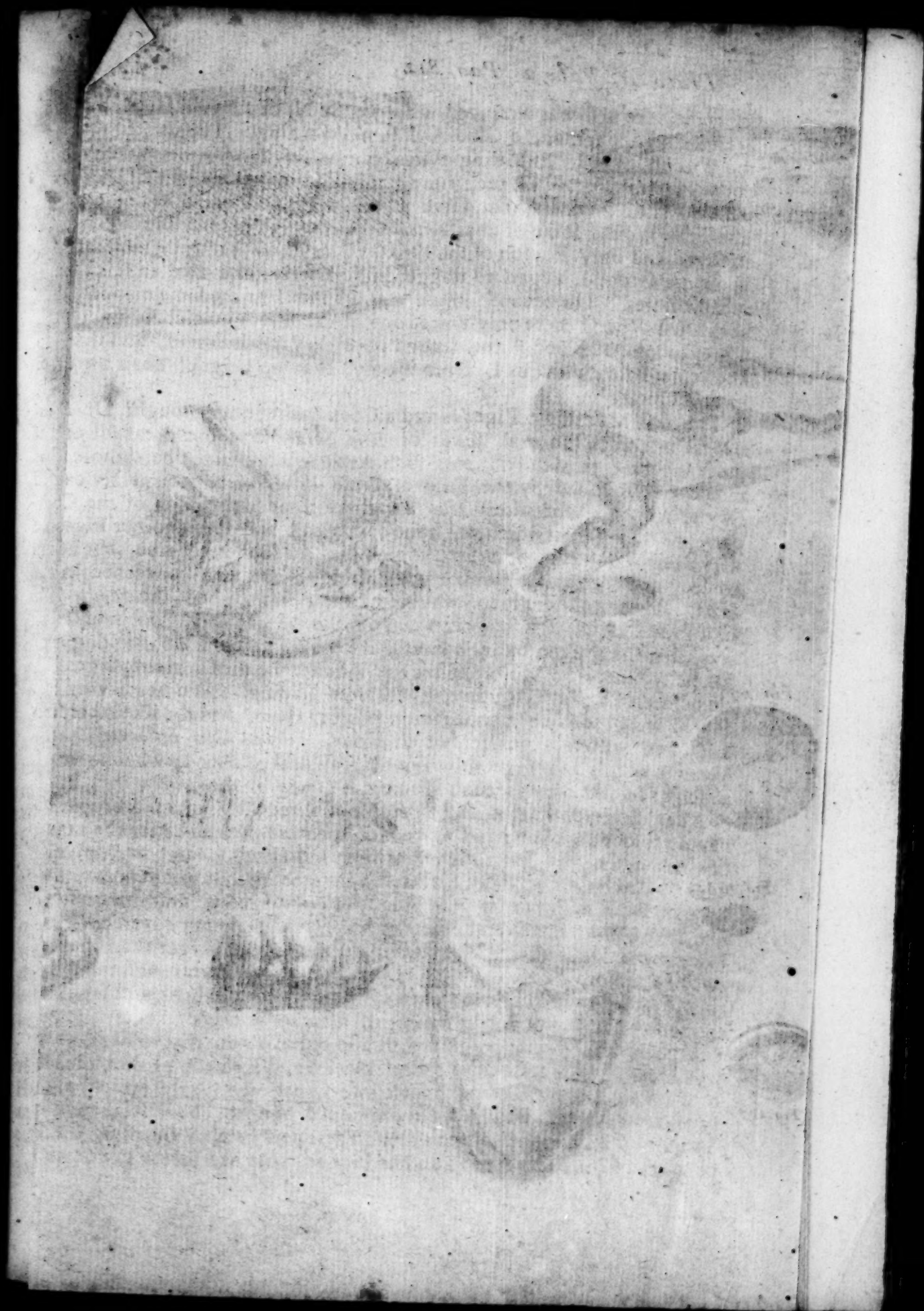




Fig. 205.

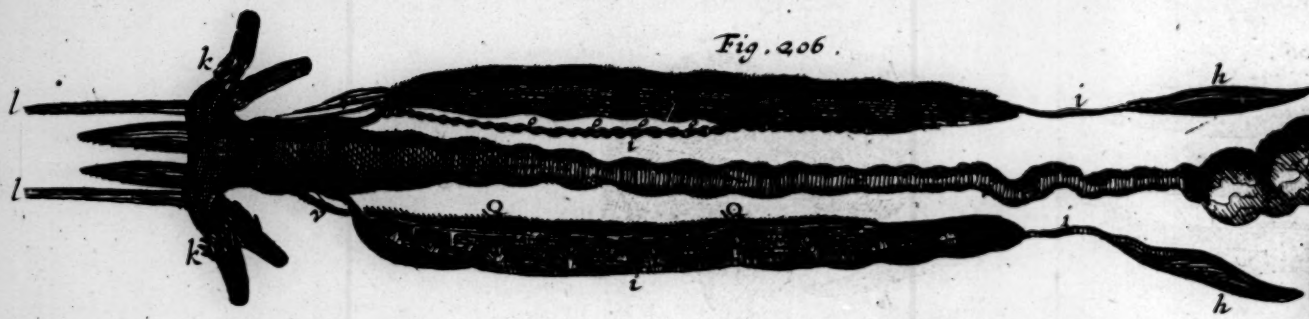


Fig. 206.



Fig. 207.

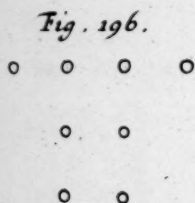


Fig. 196.

Fig. 198.



Fig. 190.



Fig. 200.



Fig. 199.

Fig. 197.



Fig. 202.

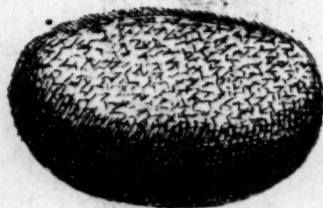


Fig. 201.



Fig. 191.

Fig. 192.



Fig. 193.

Fig. 208.

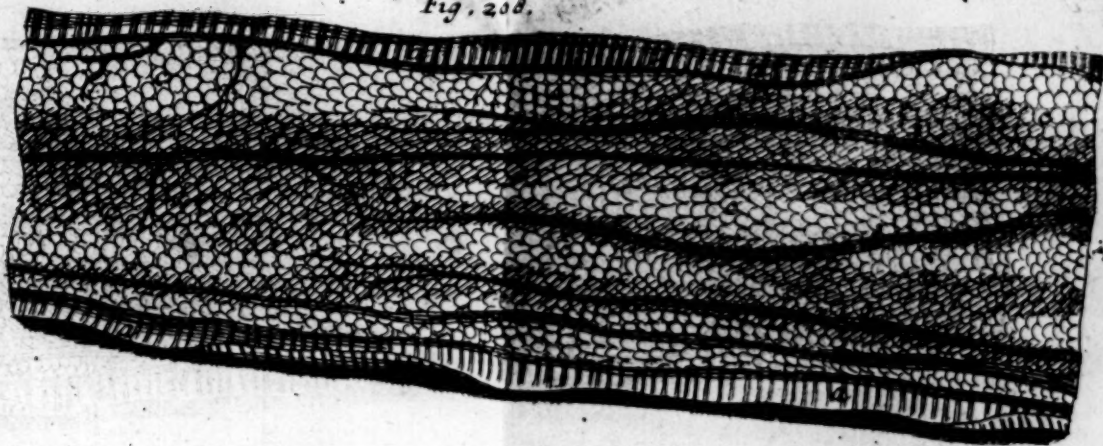


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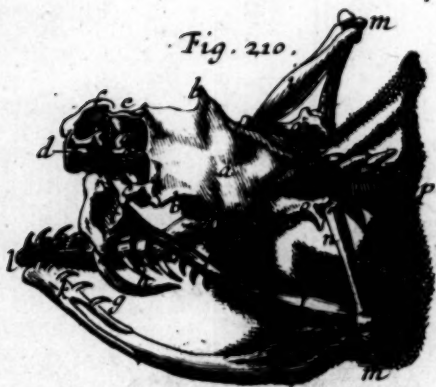


Fig. 209.

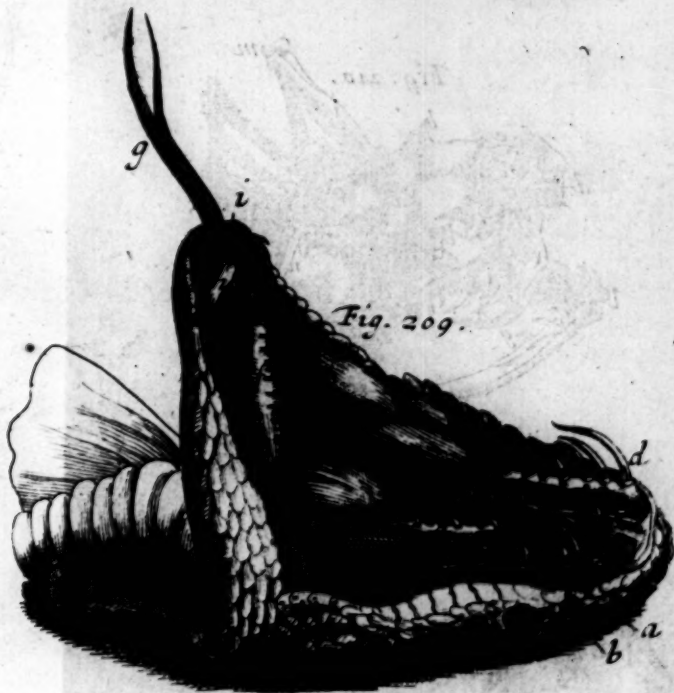


Fig. 212.



Fig. 211.



Fig. 216.



Fig. 215.



Fig. 214.



Fig. 213.



Fig. 194.

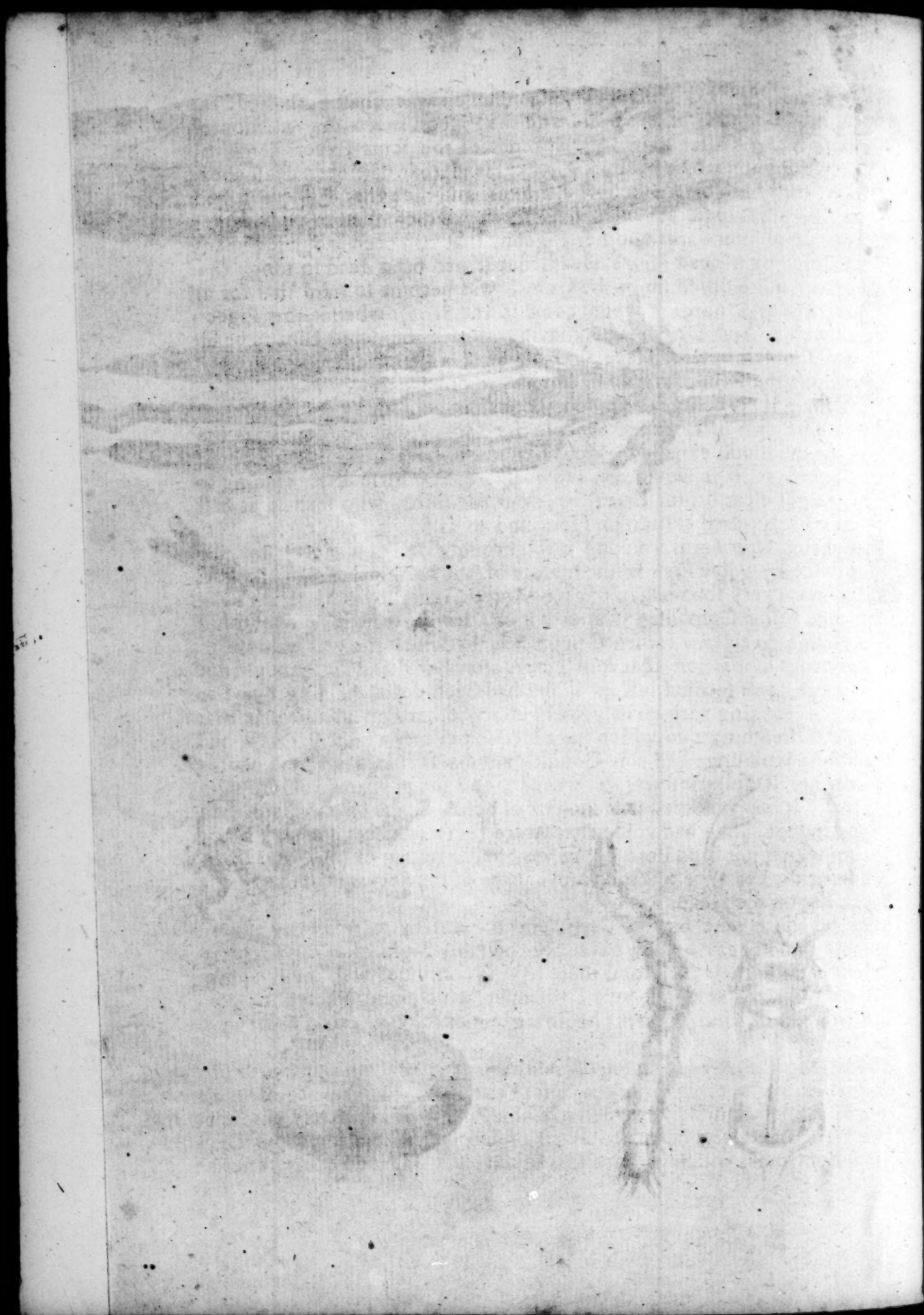


Fig. 204.



Fig. 203.





of these Heads into his Belly. The Conclusion was, that both died, the Cock within a quarter of an Hour, and the Pigeon in less than 4 Minutes.

Some few Days after, Dr. *Francini* repeated the same Experiments, by causing two Pigeons to be bit by a *Viper's* Head that had been dead above 10 Hours, they both died, one in 6 Minutes, and the other in 8. And with another *Viper's* Head he poisoned a Chicken, which died in 10 Minutes. There appeared afterwards another Pigeon, that had been wounded many Hours before, by a dead *Viper's* Head, but it had been dead so long, that the Liquor, quite dried up in the Gums, was become so hard that for all the squeezing of it nothing would come to the *Teeth*, whence this Pigeon was very well: And Dr. *Francini* having caused the same Bird to be bit again by the same dried Head, it had, after a little fluttering with his Wings whilst the Pain of the *biting* lasted, no other harm.

A live *Viper* then being taken, four Chickens were bit by it one after another. The two first, either because the Liquor did not penetrate the Wound, or the Blood expelled it, appeared not to have any Distemper; the fourth looked as if it would die presently, but a little after coming to himself, he got clear off for that time; but the third, who seemed at first to be very lively, died within an Hour and an half.

There being afterwards a young Bitch brought in, of a pretty size, she was bit twice by a live *Viper* in the middle of the hanging part of the Ear. Whereupon she very soon began to give Mortal Signs, by Staggering, Vomiting and being Convulsed: after which, having a little recover'd herself, the same Accidents returned upon her, by which she was reduced to such a grievous Condition, that four Hours after her being *bit*, she could not stir any more, and seemed just as if she had been dead, holding out her Tongue, and looking very ghastly, without any other sign of Life than that of a painful Breathing; to which she added sometimes a faint Barking, and a languishing Howling. In this Condition she was still found next Morning; only her Respiration was yet weaker, and she appeared just drawing to her end. It was observed that no part of her *Body* was swelled, nor had any Spot upon it. She had voided backward some Matter of a very black Colour, of which her hind Parts being very foul, a swarm of *Gnats* and *Wasps* were devouring her alive: Which moved one of the Servants of the House to knock her on the Head.

After this there were bit two *Capons* and a *Pullet* by a fresh *Viper*, vexed on purpose; and because they gave not then any Signs of being ill, they were sent back to their *Coops*, and there having continued well the Evening, they were surprized at Night by a Distemper, which in all likelyhood proceeded from the Poison; for next Morning one of the *Capons* and *Pullet* were found dead.

XLVII. Mr. *Rob. Burdet*, an *English Merchant* at *Aleppo*, on the fourth Oct. 1678. was bit by a *Serpent* on the left Wrist, near the Pulse towards his Hand. It seemed at first like two Pricks of a Pin; he immediately vomited, and his Wrist and Hand began to swell presently, he had some few Days before a Looseness, which perhaps this increased. He rode easily, after he

The Symptoms attending the Bite of a *Serpent*, by Mr. *John Goodyear*. n. 245, p. 351

was

was *bit*, about *two* Miles Home, and as soon as he got to his Chamber, he said he was bit by a Rat, (and would not own it was a Serpent) though a *Turk* accidentally passing by, said he saw the Serpent hang at his Wrist, as he pull'd his Hand out of the Refuge, hoping to have taken a *Hare* that he had cours'd in there. He said he felt no Pain, but a great desire to *sleep*; his Arm continued Swelling upwards, and grew black. Some little Remedies were used till the rest of the *Factory* return'd, and then they begun to cup and scarify his Arm; he having still no Pain, but a great Drowsiness; but was kept waking, to use that little time he had left, to prepare himself for Death, which he performed exceedingly well. At last the Swelling came up to his Shoulder, and then he complained much; and within a Quarter of an Hour died. He was *bit* about 10 in the Forenoon, and died about three in the Afternoon. His Body swell'd much after Death, and purged. The *Snake* was like a common *Snake* for Length, his Colour dark sandy, with black Spots, his *two* *Teeth* or *Fangs*, are like those of a *Rattle Snake* on the upper *Jaw*, the *Poison* lies in the *Gums*; and where ever they fetch blood of any Creature they certainly kill, though in some Parts sooner than in others. The People of the Country say, that if as soon as one is *bit* by a *Serpent* they shall suck immediately the Wound, they may be saved: but they must rub first the *Gums* and *Teeth* with *Oil*, that none of the *Poison* may touch any place where the Skin is broken, and spit out immediately what they suck; every time washing the Mouth, and taking more *Oil*. This *Serpent* kill'd a *Dog*, in about eight Minutes time, biting him at the end of his Ear; and *two* young *Turkeys* afterwards in *three* or *four* Minutes each, biting them at the end of a *Claw*; and then we poysoned him with the *Oil* of *Tobacco* out of a *Reed Pipe* (that had been much used, and not cleansed for a *Week* or *two*) and he died in about *two* or *three* Minutes, trembling as soon as the *Oil* was dropt into his Mouth.

A Stone
healing the
biting of a
Serpent, by
Sir Phil. Ver-
natti, n. 6
p. 102

XLVIII. Sir *Philiberto Vernatti* sometime ago sent from *Java major* (where he resided) a certain *Stone* affirmed by him to be found in the Head of a *Snake*, which laid upon any *Wound* made by any *Venomous* Creature is said to stick to it, and to draw away all *Poison*: and then, being put in *Milk*, to void it's *Poison* therein, to make the *Milk* turn blue; in which manner it must be used, till the *Wound* be cleansed. The like Account of such a *Stone* is given by M. *Thevenot* in the Relations of his *Voyages* and *Travels*.

Observations
on several
Poisons; by
Sir Theodo-
re de Ma-
yerne, n.
211. p. 15.

XLIX. The *Venome* of a *Viper* in it self is not Mortal to a Robust and sound Body: and tho very unhappy and mischievous Accidents attend it as a great *Tumour*, *Tension* and *Weight* of the Part, *Humidity* and *Variety* of Colour, *Phrensies*, *Convulsions* and *Vomitings*, yet in 8 or 10 Days at most these Accidents are over: and although the Patient may be very ill, yet he recovers again; whilst the *Poison*, having run thro' divers Parts of the Body at last always throws it self into the *Scrotum*; or *Swelling* it extreemly causes great heat and quantity of *Urine*, very hot and sharp, by which it is discharged; this *Evacuation* being the ordinary and most certain *Crisis* of the *Disease*.

It is observable that the Perspiration being obstructed by the Poison, a Man bit by a *Viper*, and swelled up, in three or four Days shall weigh almost as much more than he did before. A sickly Person, under an ill habit of Body, or fearful, dies infallibly, and in short time, by this *Venom* without speedy help. In the extream *Nervous Parts*, near the Pulse and Tongue, the bites are dangerous, and Accidents very painful. Fresh *Vipers* that have not bit, but have the *Bladders* of the *Gums* full of *Venom*, are the most mischievous: Wherefore *Mountebanks* to impose upon the People, either make their *Vipers* bite before they bring them out; or with a Needle scratch the *Gums*, and press out the Poison.

The Remedy for these great and painful *Swellings* is, to drink the *Decoction* of *Marrubium*, or the Powder taken inwardly, and a *Fermentation* with the *Decoction*, applying a *Cataplasm*, made with *Marrubium*, *Tapsus Barbatus* and *Agrimony* on the place. *Aristolochia* is also a strong and powerful *Antidote* against the *Viper*; so that if one be bit on the Tongue, he need only take a slice of this Root, beat it and apply it, and it goes away.

Pontæus, a Chymical *Mountebank* (from whom I had the abovementioned Observations) composed his *Antidote* of *Extract* of *Juniper berries* drawn with a *Decoction* of *Roots* of Round *Aristolochia*, of *Succisa*, *Marrubium album*, *Flower of Brimstone* and of *White Vitriol*. For Poison not *Corrosive*, such as those of *Animals* and *Vegetables*, and even for the *Plague* it self, (which he believes he can cure by the same Remedy) he makes use of no *Vitriol*: But if the Poison be *Sublimate*, which of it self excites Vomiting, he adds *Vitriol*; not in the proportion to *Vomit*, as a *Drachm*, but only a *Scruple* or half a *Drachm*, the Vomiting being assisted by the *Corrosive* Poison it self.

To encrease the Value of this *Antidote* with the People, when the Experiment is made on Dogs, to that Dog which they would have dye of the bite of the *Viper*, he gives with the *Antidote* a Quarter of a *Nux Vomica* not powdered but only cut in Bits, and the next Day the Dog dies. If it were powdered the Dog would die in half an Hour. He says *Nux Vomica* never vomits but shuts up the Stomach, and contracts the *Nerves* by its Poison. To preserve the Dogs alive, you must give them with the *Antidote* or any thing else, three or four Grains of *Sublimate*, which immediately sets them a Vomiting, and so saves them alive.

He offers to take all sorts of Poisons, even *Corrosives*, after an ordinary Meal, and for a Tryal of Skill, he refuses them not on an empty Stomach. He much esteems *morfus Diaboli*, *Succisa* or *Devil's bit*, against all sorts of Poisons. He laughs at the Poison of a *Toad*, which he says has none at all, no more than a *Frog*.

The manner of the Acting of the *Vipers* Poison is; In about $\frac{1}{2}$ of an Hour, a *Syncope*, or *Swooning*, seizes them with *Trembling*, and *Convulsion*, *Tingling* of the *Ears*, and frequently *Deafness* for a Moment; next as it were a white Sail comes before their Eyes, which soon vanishes: On the place of the bite a *Swelling* rises, at first of the bigness of a *Pea*, which grows as big

as a *Bean* or a *Nut*, and encreasing enlarges it self over the neighbouring parts, to a very considerable *Tumour* and stretching of the *Flesh*, which grows *edematous*, and by little and little falls into the *Scrotum*, and leaves the Part *black*, *blue* and *yellow*. It makes as it were *Bags* in the *Skin*, which feel heavy when you walk, as if fill'd with *Quick silver*. Do what you will, the *Poison* will have its *Course*; and it is usually three *Days* before it comes to the height, and as long abating.

He says the *Gall* of the *Viper* is no ways *venomous*: all the *Poison* is in a *Liquor* in the *Gums*, which is yellow like *Oil*; of which you may easily disarm the *Viper*. The *Viper* is most *venomous* of *Serpents*; the *Asp* is but a *Species* of the *Viper*. The *Napellus* is a very dangerous *Poison*, acting by its *Acrimony*: but you must take a great quantity of it. It burns the *Throat* extreemly, as does *Alum*; but it is cured by the *Antidote*. *Crude Antimony* does nothing if attacked by the *Antidote*.

The most mischievous of all *Poisons* is *Opium*; of which having given an excessive Quantity to a *Servant*, at first he had *Convulsions*; then strange *Vomitings*, not able to let any thing go down into his *Stomach*; a *Sleepiness* following; all which time they kept him *awake* as much as possible. At last all of a sudden, he grew well, and called for *Viſuals*.

L. Salaman-
der, By S.
Steno, n. 2.
p. 377.

L. M. Steno writes from *Rome*, that a *Knight* called *Corvini* had assured him, that having cast a *Salamander*, brought him out of the *Indies*, into the *Fire*, the *Animal* thereupon swell'd presently, and then vomited store of thick slimy Matter, which did put out the neighbouring *Coals*, to which the *Salamander* retired immediately, Putting them out again in the same manner, as soon as they *Rekindled*; and by this means saving himself from the force of the *Fire* for the space of 2 *Hours*; that afterwards it lived 9 *Months*, that he had kept it 11 *Months*, without any other *Food*, but what it took by *Licking* the *Earth*, on which it moved, and on which it had been brought out of the *Indies*, which at first was covered with a thick *Moisture*, but being dried afterwards, the *Urine* of the *Animal* served to moisten the same; but being put upon *Italian Earth* it died 3 *Days* after.

Observations
on a Came-
leon, By D.
Jonath. Gol-
dard, n. 137.
p. 230.

LI. This *Cameleon* was a *Female*; the *Skin* appeared mixt of several Colours like a *Medley Cloth*: *Lighter* towards the *Belly*, otherwise near upon it, equally mixed. The Colours discernable are *Green*, a *Sandy-Yellow*, a deeper *Yellow* towards a *Liver Colour*: and indeed one may easily fancy some Mixture of all or most Colours in the *Skin*; whereof some are more predominant at some times. There are some permanent black *Spots* on the *Ridge* of the *Back*, and on the *Head*. Upon *Excitation*, or *Warming*, she becomes suddenly full of black *Spots* of the bigness of a great *Pins Head* equally dispersed on the *sides*, with small black *Streaks* on the *Eye-lids*; all which afterward do vanish. The *Skin* is grained with globular *Inequalities*, like the *Leather* called *Shagreen*. The grossest *Grain* is about the *Head*, next on the *Ridge* of the *Back*, next on the *Legs*; on the *Sides* and *Belly* finest: Which perhaps in several *Postures*, may shew several Colours, and when the Creature

Creature is in full Vigour, may also have in some sort *Rationem Speculi*, and *Reflect* the Colours of Bodies adjacent: Which, together with the Mixture of Colours in the Skin, may have given Occasion to the old Tradition of Changing into all Colours.

The Eyes resemble a *Lens*, or *Convex-Glass*, set in a Versatile Globular *Socket*; which she turned *backward*, or any way, without moving her Head. And ordinarily the one a contrary or quite different way from the other. The Tongue (which she was never seen to put forth of late, though she often opened her Mouth wide) was easily drawn out, when she was dead, to half the length of her Body, being round and full towards the end, like a *Pestil*, with some Cavity at the Extremity: Having a *Bone* about half the length of it, toward the Root; over which also the Fore part would slip *backward*. The *Bone*, where connected to the Body, is Bifurcated. She hath *Teeth* plainly to be felt and seen above and below, on the whole Circumference of the *Jaw*.

The Trunk of the Body, for the Structure of it, is all *Thorax*, or *Breast*, having *Ribs* from the *Neck* to the setting on of the *Tail*. The *Ribs* are of two sorts; the larger above tending *backward* from the *Spine* or *Back Bone*; the other, from the Extremities of the former, tending *forward*, as in the *Breasts* of *Fowls*. There is a kind of *Diaphragm*, a thin Transparent *Membrane*, as in *Birds*, separating a small Portion, about the fourth part of the *Cavity* next the *Belly*, from the rest: Wherein is contained a small *Ventricle* connexed to the *Gula*; to which is continued an *Intestine*, having some little *Convolution* in the Conveyance of it; which extended might be about the length of the whole Body, with Head and Tail. The *Excrements* therein black or of a *Sad French Green*. She had a small thin Liver contiguous to the upper part of the *Diaphragm*: in part divided into 2 *Lobes*, of a blackish, or very *sad Colour*. The *Lungs* seemed to be made of *membranous Cells*, or *Divisions*, very thin and transparent, resembling a little light *Froth*. The *Heart* was firm and fleshy, but very small; and at the very fore End of all the *Breast*, or Body. At the hinder End of the Body was a double *Ovary*, consisting of 5 or 6 Eggs (of the bigness of the greatest Pins Heads, and sticking to the Back) on each side; of the same Colour and Consistence with those of the Yolk of an Egg.

LII. Miratus sum valde, D. Thrustono in *Testudinum*, *Lacertarum* & *Rana-* Observations about the
Sectionibus non occurrisset *Commercium* inter *Bronchia* & *Pulmones*, Lungs of
 quos *Vesiculas*, a laxitate Exterioris *Pulmonum Membranae* obortas, vocat; Frogs, by S. Malpighi, n. 71. p. 2149
 cum sane immissa in *Tracheam* *Fistula* & simul insufflato Aere, *Pulmones*
 eidem *Tracheae* appensi hinc inde circa *Cor* turgeant; quod & ad libitum
 Animalis frequenter accidit: Hi etiam dum Aere turgent, si filo innodentur
 ut siccescant, secti patenter oculis *Cellulas* & *Vesiculas*, evidenter *Mem-* D'atriba de Respir. Usa Primariis
braneas exhibent. Et licet in *Ranis* brevis sit *bronchiorum* processus, a *Larynge*
 tamen bini *Ductus*, Semicircularibus aliquot *Annulis* conflati, in *membranaceas*
Vesiculas hiant; atque ita succedit *Inspiratio* & *Expiratio*. At in *Testudine*,
 Vol. II. M m m m m *Lacertis*

Lacertis & similibus oblonga *Trachæa* in binos subdivisa Ramos, Aerem *Pulmonaribus Vesiculis* subministrat. Scio in *Ranis*, prope *Os*, hinc inde binas interdum turgentes erumpere *Vesiculas*, (procul tamen a *Pulmonibus*) quæ *Eucæ* sunt Appendices, & Aere interdum, a *Pulmonibus* in *Oris* Cavitatem *Expiratione* propulso, foras exilire.

Circa exaratos *Pulmones* Reticularem *Musculum* locari scias, cujus *Carneus* Plexus, Sinus, & *Vesiculas* ambientes, alias ruditer delineavi. Hujus Mirabilis Contextus patet in *Ranis*, & *Lacertis* præcipue; nam Multiplices *Carnei* *Lacerti* per Longum producuntur, & Transversaliter elongatis *Fibris* invicem continuantur: intermedia vero aræ Reticularibus *Carnei* Plexibus ulterius occupantur, non absimili ritu ac in *Arborum* *Foliis* accidit: *Retis* autem enarrata hæc Minora Spatia rectis postremo *Fibris*, quasi brevibus *Tendinibus*, pervaduntur. Mirabilis hic *Musculus* non exteriorem tantum *Pulmonum* ambit Regionem, sed interiores quascunque *Vesiculas* & Sinus circumdat, ita ut, suo Motu singulas *Pulmonis* partes comprimendo, *Expirationem* Sonumque promoveat. Hæceadem Structura in *Pulmonibus* Perfectorum Animalium proportionaliter observatur, & in *Agnorum* extremis præcipue *Labulis*, Aere turgidis, & adhuc *Mollibus*, patet.

The Production of Tadpoles, by Mr. Rich. Waller. n. 193. p. 523. Fig. 217.

Fig. 218.
Fig. 219.

Fig. 220.
Fig. 221.

Fig. 222.
Fig. 223.

LIII. Mar. 12. 1689. I took some Frog-Spawn out of a Ditch, which I suppose might have been spawned about 14 Days, and kept it in a Gally-Pot of Water; which I shifted every Day or two, and kept them in a Window where the Sun shined some Part of the Day. At the first, they appear'd as in Fig. 217. being a round black Globule, encompass'd with a clear Liqueur as I afterwards found, and a Membrane encompassing that Liqueur, and that encompassed with a larger Sphere of a more mucous Liqueur. The second Day they appear'd as Fig. 218. The third Day as Fig. 218. The fourth Day as Fig. 219. About the sixth Day, several of them were loosed from their Eggs, and on the seventh and eighth more of them: when they appear'd of the shape of Fig. 220. which in Fig. 221, is represented bigger than the Life, that the Posture they lay in may be seen the better. On the seventh and eighth Days, upon pricking of them with the Point of a Needle, they would contract themselves; some of them, on the eighth Day, would of themselves bend their Bodies, but not move out of their Place. When they first got thro' their Egg (which I suppose they did by eating their Way) they hung fast upon the outside of it, by that Part which I afterwards found to be their Mouth, and when loosed from their hold, they sunk to the bottom of the Water, and could not rise again. On the 9th Day they were not visibly increased in bulk, only they moved themselves more freely at the bottom of the Vessel.

At about 14 Days end they appeared as Fig. 222. at which time they swam about in the Water by moving their Tails as Fig. 223. and some Rudiments of their Fore-Legs were visible, which looked Forked and like the Sprig of a Plant. At three Weeks end their Mouths were to be seen, which they opened and shut, and emitted Faces from the other End. At a Months end the Eyes were to be discerned, at which time they would swim near the

Top of the Water, and opening their Mouths let out a small Bubble of Air, and I suppose take in fresh.

The Liquor which was contained in the innermost *Membrane*, was more transparent than the other, which was a *mucous Liquor*, and like the White of an Egg, the whole was a little heavier in specie than Water, for a single Egg sunk when loosed from the rest ; but when they were fastened a great many together, they *swam*, every 3 Eggs, leaving a little space, which being fill'd with Air, made them specifically lighter than common Water.

LIV. The *Ductus Animalis* in *Animals*, from its uses, may ordinarily be divided into 4 Parts. 1. That which conveys the Food, as the *Oesophagus*. 2. That which digests or corrodes it, the *Stomach*. 3. That which distributes the *Chyle*, the *Intestine*. 4. That which empties the *Fæces*, the *Rectum*. But a *Leech* is all *Stomach*, from one end to the other, and does devour at a *Meal* several times the Weight of its whole Body. The *Stomach* when swelled and stretcht with Blood is far bigger than the *Leech* it self, nay several times exceeds it. But I mistook the Number, it was not one, but many *Stomachs*, for the Cavity is divided into several *transverse Membranes*, in divers distinct *Camera's*, but these *Membranes* in the Middle have a Hole that leads from one into the other ; but by the pouching out of each side, each of these may be reckon'd also two ; in all we may number, (there being 10 or 12 of these *Camera's*, besides these 2 long Ones, which at last run to the Tail) at least 22, if not 24 *Stomachs*. But the *Rectum*, which lies between the Forking of the two last long *Sacculi*, or *Stomachs*, is but small, and short in Respect of the whole.

*The Stomach
of a Leech,
by Dr. Edw.
Tyson, n.
144. f. 33.*

LV. The *Upper Lip* of a *Leech* is stretched out into a Point, and falls upon the *Under*, which is round, like a *Crescent*, and shorter. Its Throat on the inside is covered with a great many *white Muscles*, about 5 or 6 Lines long, as big as a small Thread, and lying parallel one to another, along its Body. When it applies the Mouth to the Flesh of any *Animal*, all these *Muscles* contracting themselves, she sucks it with so great Violence and Greediness, that she makes it enter in Form of a little *Pap* into its Throat. So that all the Effect of Suction terminating in a very little space, of necessity the Flesh must break in that Place.

*The Anatomy
of a Leech,
by M. Fr.
Poupart, n.
233, p. 722.*

There is seen at the End of its *Tail*, a little flat thing, exactly round, the Border of which is elevated far above the *Tail*, and all round it; which it applies so uniformly upon the Bodies to which it fastens it self, that it touches them in all their Parts, and then drawing up a little the middle of this flat part, without taking off the Edges, she makes of it, as it were, a little *Balm*, which leaves its *Cavity* in its Middle. This excellent *Glue* fastens so strongly on the *Tail* of the *Leech*, that 'tis a hard Matter to pull it away without making some Rent, especially if you draw it perpendicularly from the Surface on which the *Animal* is fastened. It has always Recourse to this little Instrument, for fastening its Body, to the End it may not be suspended in the

M m m m m 2

Air,

Air, while it draws its Nourishment by Suction, or else that it be not carried away with the Current of the Water, while it carries its Head here and there for seeking its Nourishment.

Its Gut goes in a straight Line from the Mouth to the *Anus*, as big as a Goose's Quill, all along set with a great Number of little *Valves*: Some of which make a perfect Circle, with a Hole in the middle, and others a half-moon, some are shap'd *Spiral ways*, and there is a great one of this sort near the Tail, fashioned like the Heart, which leaves only a very little Hole, near which is found much yellow Fat, which fills all the Cavity of the *Intestine* to half an Inch. Two little *Intestines* or *Appendixes*, each half an Inch long and of the Bigness of the Feather of a little Bird's Wing, pierce the great Gut, in which they are open at one End, and shut at the other. All this Structure makes it evident, why the *Intestine*, which makes no Convolutions, and yet reserves ordinarily but liquid Aliments, does yet retain them to a perfect Concoction.

A Nerve, the Bigness of a Horse-Hair, all black, hard to break, having Knots at a Distance one from the other, beginning at the Mouth of the Animal, passes over the Parts that serve for Generation in the male; 'tis fastened in a straight Line all along the Gut above, ends at the little Circle in the End of the Tail, and in the Way sends out Branches to the right and left Side, which go from every Knot. 'Tis very probable, that by this Canal, the Animal Spirits run abundantly, which gives so great Briskness to this Reptile, which makes it ply into so many Fashions, swim so swiftly, so properly, and suck with such Greediness.

The Leech is *Hermaphrodite*, the Parts of the male destinated to Generation are placed where the Neck ought to be. The Yard, which is about 2 Inches long, is white, round, hollow and gristly: A part of the Yard, which is always in the Body, is a Sheath, about 15 Lines of an Inch long, as big as a little Bird's Quill, covered with a fine membrane, which fastens it strongly to the Belly, round about a little Hole given the Leech for putting out and in his Yard when he pleases, and not for Breathing as the Ancients said. The other Part of the Yard which comes out 9 or 10 Lines of an Inch, is the Bigness of a sowing Thread, and the End of it, for the Length of two Lines, is bigger than the rest. All the Yard is hollow, and has in his Cavity a white Muscle as big as a Hair, fastened only to the Root and Head, all the rest being at Liberty. 'Tis with this Muscle that the Animal draws the Yard into its Sheath, which any one may try by Cutting it at the Root, to draw out this Muscle with his Nails. On every side of the Root of the Yard is a little white Web, flat, oval, about 2 or 3 Lines long, resembling small Guts, twisted about with a Cartilaginous Body, as big as a double Thread, and 2 Lines long, which fastens to the Root of the Yard, in which 'tis probable it carries the Prolifick matter. A little above the Root of the Yard between these two Webbs, there is a little Gristly Globule, two Inches long, white, hard, hollow, round, oval, sharp, inwardly covered with a Membrane, wrinkled and full of a milky Liquor. There is at the Head of this Globule a small Web, like to an Epididymis, whose little Canal, of the same Piece with it, creeps

creeps over the *Globule*, and is fastened at the Point of it, and above the *Epididymis* are two *Glands* exactly round, each as big as a Grain of *Millet*. I take this little *Globule* to be a *Testicle*. All along every side of the *Intestine* is a white Canal, or *Ovarium*, of the bigness of a small twisted Thread, and folded in a thousand Manners, to which are fastened with a *Tail*, as it were the Grain of a Raisin to their *Grape*, many little *Globules* exactly round, as big as a little Pea, full of a milky Juice, and some little white Eggs, gristly, perfectly round, as big as a Grain of *Millet*, hard, which are hardly broken, making a Noise, and full of a white Matter. There is in the *Intestine*, towards the End, a great *Valve* fashioned like a Heart, with two little Bags, where begin 1000 small Channels made of fine yellow Fat which fill the Cavity of the *Intestine* for half an Inch. It's probable that these Passages of Fat receive the Prolifick Liquor to conduct it into the *Ovarium*.

LVI. There is an extraordinary *Sanguisuga* or *Leech*, found sometimes sticking fast in the Fish call'd *Xipbias*, or *Sword fish*. *S. Boccone* gives it the Name of *Hirudo*, or *Acus Cauda utrinque pennata*, because of its working it self into the Flesh, and sucking the Blood of the said Fish. He describes it to be of about 4 Inches long, the Belly of it white, cartilaginous and transparent, without Eyes or Head, (that he could observe) but instead of a Head, it had a hollow Snout, encompassed with a very hard *Membrane*, differing in Colour and Substance from the Belly; which Snout it thrusts whole into the Body of the Fish, as strongly as an *Augre* is wound into a piece of *Wood*, and fills it full of Blood unto the very Orifice. It hath a Tail shaped like a *Feather*, serving for its Motion, and under it two Filaments, or slender Fibres, longer than the whole Insect, whereby it seems it clings about Stones or Herbs, and sticks the closer in the Body of the *Sword Fish*, of which it attacks those Parts only where the Fins of the Fish cannot touch or trouble it, the Observer affirming that he hath often found it sticking in the Back, and in the *Belly*, and sometimes close to the Head, sometimes close to the Tail of that Fish, but always far enough from the Fins. Within its Belly he noted some Vessels like small Guts, reaching from one end of it to the other, which by the Pressure of his Nail, he made reach to the Orifice of the *Snout*, whence they retired back of themselves to their natural Situation; they seeming to be the Instruments for sucking the Blood, because the *Snout* is in it self an empty part, destitute of Fibres and Valves, to draw and suck with; whereas these Vessels having a Motion resembling that of a Pump, in which the Snout of this Animal serves for a Sucker, drawing the Blood from one end to the other: And the Belly of this Insect being fram'd Ring-wise, the Structure serves to thrust the said inner Vessels into the Orifice of the Trunk, and to draw them back again.

This Creature as it torments the *Sword-fish*, so it is, by our Observer's Relation, vexed it self by another Insect, which he calls a *Louse*, of an *Asb* Colour, fastened toward the Tail of this Leech as firmly as a Sea-snail is to a Rock. 'Tis of the Bigness of a *Pea*, and hath an Opening, whence come

An extraor-
dinary Leech
which tor-
ments the
Sword fish,
by *S. Paulo*
Boccone, n.
99. p. 6159

out

out many small winding and hairy Threads. It hath not been observed, (as far as our Author could learn) to trouble, or to be upon any other Animal than this *Leech*.

*The odd Turn
of some Shell
Snails, by Dr.
M. Lister,
n. 50. p. 1011
n. 72. p. 2171*

LVII. I have found 2 sorts of *Shell Snails* easily distinguished one from another, and from all besides, because the Turn of the *Wreaths* is from the Right Hand to the Left, contrary to what may be seen in common *Snails*. They are very small, and therefore might well escape thus long the more curious Naturalists; either of them much exceeding, at least in Thickness, a large *Oat Corn*.

The first I thus describe. The Open of the *Shell* is pretty round; the Second Turn or *Wreath*, is very large for the Proportion, and the rest of the *Wreaths*, about the Number of six are still lessened to a Point. This *Turban*, or *Conical Figure*, is well near a Quarter of an Inch; the Colour of the Shell is dusky, yet when the shrunk Animal gives leave, you may see Day through it, and then it is of a yellowish Colour. These *Shells* are extremely brittle and tender.

The second sort seem to be much stronger and thicker shell'd, they are well near half as long again as the other, and as slender, they have the exact Figure of *Oat Corn*, being as it were, pointed at both Ends, and the Middle a little swelled. The Open of the Shell is not exactly round, there being a peculiar Sinus in the lower part thereof. I think you may number about 10 Spires, having their Turn from the Right Hand to the Left. The Colour of the Shell is of a dark and reddish brown.

Both these sorts of Snails when they creep, lift up the Point of their Shells towards a Perpendicular, and exert, with Part of their Body, 2 pair of Horns, as most of their Kind do.

Cat. Plant. In March I have seen many of them pair'd, and in the very Act of Venery, and therefore it is most certain, (contrary to the Opinion of *Aristotle*) that they engender. But whether those that are thus found coupled, be one of them *Male* and the other *Female*, or rather, as Mr. Wray hath observed, that they are both Male and Female, and do, in the Act of Generation, both receive into themselves, and immit a like *Penis* (as it seems probable to any Man that shall part them) I shall not determine.

These Snails are to be found frequent enough under the loose Bark of Trees, as old *Willows*, and in the ragged Clefts of *Elms* and *Oaks*, &c. and in no other Place that I could observe.

*Some sort of
Virginian
Snails, by
Mr. J. Banister,
n. 198.
p. 671.*

LVIII. 1. The Outside of one sort of *Land-snails* in *Virginia*, is of *Ash-colour*, inclining to a yellow, the inside white, with a Blush of red, and in the Middle of the Entry, on the Inturn of the Shell, grows a small white Tooth or Protuberance. But what is most remarkable, the Shell it self is transparent, and you may plainly perceive by the Opacity there, that the body of the Animal lies near the spiral String, or Center, on which the Arch is turned, and that the empty Part of the Shell is spread with a thin spotted Film. Near the Tooth, but more inward, is to be seen a little *waterish Speck*, which

which by a kind of *Systole* and *Diaſtole*, contracts and dilates it ſelf ; from this proceeds a limpid *Trunk*, which runs into the *Film*, and there divides into *branches* : theſe grow leſſer, and ſpread as the *Animal* recedes, or approaches the Mouth ; and when it is out, extend themſelves to the very Lip of the Shell. I ſuppoſe the ſame to be in all, at leaſt the Land Kind, tho' not eaſily to be diſcerned. It is likely alſo, that the *Film*, the *Nautilus* or *Carvil* (as the Sailors call it) exerts, may be analogous to this.

2. This Deſcription of the Heart of a *Snail*, agrees well with the Anato- By Dr Liſter, my thereof, made and long ſince publiſhed by *Harder*, and *Fr. Redi*. ib.

3. There is a ſmall *Snail* of the Land Kind, with a dented Aperture, By M. Boni- and an outward Coat, on which it is *Hirſute*, or rather finely echinated. ſter, ibs p. 672. I am apt to believe, that theſe (nor hardly any elſe) are not dented, till they are at their full Growth, for I find ſeveral ſmall ones amongſt them, with an open Entrance, that ſeem to belong to this Kind.

I have hitherto obſerved very little Variety of naked *Snails*, I know of but one Kind, which is a ſmall *Aſh-coloured* and *ſpotted* one, and *milky*, like Dr. Liſter's Fig. 16.

LIX. In Oct. 1684. There were two Ladies at *Minhead* where I then was, The Purple? who told me, that there was a certain Perſon living by the Sea ſide in *Ire-* Fiſh. by Mr. land, who made conſiderable Gain, by marking with a delicate durable Will. Cole, n. *Crimſon Colour*, fine Linnen of *Ladies, Gent. &c.* ſent from any Parts of that 178. p. 1278. Iſland, with their Names, or otherwiſe, as they pleaſed, which was made with ſome liquid Subſtance taken out of a *Shell-fiſh*, and one of them thought it to be taken out of the Shells here figur'd and deſcrib'd. Hereupon I made many Experiments on all the Shell Fiſhes I had taken on that Coaſt ; Fig. 223, 224 and at laſt obtained that delicate Colour they told me of. The whole Pro- 225, 226, ceſs is as followeth. 227, 228.

The ſhells being harder than moſt of other Kinds, are to be broken with a ſmart ſtroke with a *Hammer*, on a Plate of Iron, or firm piece of Timber, (with their *Mouths* downwards) ſo as not to cruſh the Body of the *Fiſh* within ; The broken pieces being pickt off, there will appear a white Vein, lying tranſverſly in a little Furrow or Cleft, next to the Head of the Fiſh, which muſt be digged out with the ſtiff Point of a Horſe-hair pencil, being made ſhort and tapering. The *Letters, Figures*, or what elſe ſhall be made on the Linnen (and perhaps Silk too) will preſently appear of a pleaſant light green Colour, and if placed in the Sun, will change into the following Colours, i. e. if in *Winter*, about Noon, if in the *Summer*, an Hour or two after Sun-riſing, and ſo much before ſetting, for in the Heat of the Day, in Summer, the Colours will come on ſo faſt, that the Succeſſion of each Colour will ſcarcely be diſtinguiſht, next to the firſt light green, it will appear of a deep green, and in few *Minutes* change into a full *Sea-green*, after which, in a few Minutes more, it will alter into a *Watchet Blue* ; from that, in a little time more, it will be of a purpliſh Red, after which, lying an Hour or

two.

two, (supposing the Sun still shining) it will be of a very deep purple red, beyond which the Sun can do no more. But then the last and most beautiful Colour, after washing in scalding Water and Sope, will, the Matter being again put out into the Sun or Wind to dry, be a fair bright *Crimson*, or near to the Prince's Colour, which afterwards, notwithstanding there is no use of any *Stiptick* to bind the Colour, will continue the same, if well ordered; as I have found in *Handkerchiefs*, that have been washed more than 40 times; only it will be somewhat allay'd, from what it was, after the first washing. While the Cloth so writ upon lies in the Sun, it will yield a very strong foetid Smell, as if *Garlick* and *Asa Fœtida* were mixed together.

The Shells are of divers Colours, but most part of them white, some are red, some yellow; others of both these Colours; some of a blackish brown; many of a sandy Colour, and some few striped with white and brown parallel Lines. It seems to be a kind of *amphibious Animal*, alternately living in both Elements every Tide: For being out of their native Place, and in Want of such Vicissitudes, they take this Course to find the Air; when any of them are put into a Vessel of Sea-water (for in fresh they soon expire) after they have lain sometime on the bottom of the Vessel, they creeping to the Superficies of the Water, and by extending a kind of Lip, with their *Operculums*, cling to the Side of the Vessel or Pan, (which is most convenient for their Ascent) with about half that Part above the Water; sometimes

Fig. 229. creeping down under it, and returning again to their Station between Wind and Water.

I have found, that sometimes their Veins are fuller and whiter, and the Juice more viscid, at other times more flaccid and watery.

These Shells are in great abundance on the Sea-coast of *Somersetshire*: I have found them also on the shores of *South Wales*, opposite to it; and I doubt not, but they may be found on the other Coasts of *England*, especially the *South* and *Western* Parts, where I am almost assured I have formerly seen them, tho' then unknown to me. And I am of opinion, there may be found on our Marine Coasts, some bigger Shells, which may have a colouring Juice, though not the same with this, for that I know few natural things both of *Animals* and *Vegetables*, but what have divers sorts of the same kind, in the same Place.

I am assured by some, who have boil'd, drest and eaten of this Fish, that they are wholesome Food; as good at least, and taste as well as *Lympos* or *Winkles*, only the Flesh is something harder.

Perhaps this colouring Juice may be the spermatick and prolifick Matter, by which they propagate their Kind: which I am inclinable to think, from its Consistence, Virulent and Foetid Savour. Or else it may be a Humour in this Animal, which by its vital Energy, as the Spring of Life and Motion, supplies the Want of *Heart*, *Liver*, *Blood*, &c. as in other exsanguineous Animals

There are many sorts of this *Purple Fish*, differing in Bigness, Structure, Colour of the Shell, according to the Nature of the *Sea Grounds*, Depth, or Shallow-

Shallowness of *Water*, *Rocks*, *Gravel*, *Mud*, as also the *Latitude*, where they are found; and so differing also in the *Varieties* of *Colours* of the *Tinging Juice* in their *Veins*, as *black*, *livid*, *violaceous*, *deep Sea-green*, *light* and *deep Red*, *Amethyfine*, &c. But the best of all were found in the *Tyrian Seas*, near that *Island* on which the renowned *City* of *Tyre* was built, (now an inconsiderable *Town* called *Sur*); this was celebrated and priz'd above all the rest, for that it excelled them all in its illustrious *Colour*, called in former *Ages* by divers *Names*; as *Ostrum*, *Sarranum*, *Pelagium*, *Venenum*, *Tyrium*, *Purpurissum*, *Flores Tyriani*, &c. Almost all *Authors* agree, that it lies in a certain *Vein* in the *Fish*; and some of them mention it to be white and viscous, as this of ours is. This excellent *Dye* seems to have arrived at its highest *Perfection* in the *Days* of *Pliny* (being in the *Reigns* of the *Vespasians*) when the *Artists* of the *Imperial City* of the *World*, in *Preparations* of that *Tinging Succus* for *dying* the *Robes* and other *Vestments* of *Emperors*, *Senators*, &c. strove to excel each other in new fashion'd *Purples*, to gratify the luxuriant *Excess* of the *Great Ones* of those *Times*, by preparing and mixing the *Colour* found in the several sorts of these shells. These *Colours* sold then at great *Prices*; that which was the fine double dy'd *Purple* of *Tyre*, called *Diabapha*, yielded 1000 *Roman Denarii* the *Pound*, which is computed to be more than 30 *l. Sterling*: And this of ours being so excellent a *Colour*, without a *Preparation*, or *Addition* of any thing to it, may now, or at least hereafter, by farther *Improvement*, vye with the *Tyrian Purple*.

Johnston, out of *Aristotle*, mentions a *Species* of these *Fishes*, under the *Name* of *Littorales quæ parvæ & Flore sunt rubro*; this agrees with ours, which may be named *Purpura Littoralis (sive Teniensis) parva Turbinata*.

LX. *Octob.* 7. 1651. *Testudinem* meam appendi, priusquam *Latibulum* Observations on a Tortoise, by Sir Geo. Ent. n. 194. p. 533 adiret, ibidem per totam *Hyemem Hybernatura*, pendeatque exacte 4 lib. 3 Un. 7 Dr.

Oct. 8. 1652. *Erutam* e *Terra Testudinem* (nam se pridie humaverat) appendi denuo, ponderabatque 4 lib. 6 Un. 1 Dr.

Mar. 16. 1652-3, *Testudo* sponte e *Latibulo* suo prodiit, pendeatque 4 lb. 4 un.

Oct. 4. 1653. *Testudo* postquam per aliquot dies jejunasset, subitusque terram sese abscondisset, inde educta atque appensa, ponderabat 4 lib. 5 un. *Oculi* (quos diu clausos habuerat) tum aperti plurimum madescebant.

Mar. 18. 1653-4. *Testudo* e *Latebris* prodiens, & in *Lance* appensa, ponderabat 4 lib. 4 un. 2 dr.

Oct. 6. 1654. *Testudo* ad *Hyberna* ituriens pendeat 4 lib. 9 un. 3 dr.

Die Feb. ultimo 1654-5. *Testudo* ex *Hyemali Crypta* prorepens pependit 4 lib. 7 un. 6 dr. amisit itaque ponderis 1 un. 5 dr.

Oct. 2. 1655. *Testudo Hyematum* itura, pependit 4 lib. 9 un. prius autem aliquandiu jejunaverat.

Mar. 25. 1656. *Testudinem* e Latebris Hybernalibus prodeuntem appendi, eratque 4 lib. 7 Un. 2 Dr.

Sept. 30. 1656. *Testudo*, subtus terram ituriens, pendebat 4 lib. 12 un. 4 dr.

Mar. 5. 1657. *Testudo*, de subtus terram exiens, pondo erat 4 lib. 11 Un. 2 Dr. ss.

Unde satis liquet quam Fixis Particulis hæc Animalia, quæ sub Terra se muniunt adversus *Frigus Hybernium* constant; cum per tot Menses tam exigua pars corporis in sudores aut effluvia abeat, ut an vivant necne, dum hunc in modum sepulta jacent, merito ambigatur.

A Tortoise
living 3 days
without a
Head, by M.
... n. 26.p.
480.
A sort of Oy-
sters in East-
India, by M.
Witzen. n.
203, p. 871.
Fig. 230.
By Dr. Lister
ib. p. 872.

LXI. S. Steno writes from Florence, that a *Tortoise* had its Head cut off, and yet it was found to move its Feet 3 Days after.

LXII. 1. In the River of Goa, there is a Shell represented in Fig. 230: which holds a sort of *Oyster*; it is very scarce, and in the Indies, as well as here in Holland, the shell powder'd is esteem'd a good Medicine.

2. The like sort of *Oyster-shells* is to be found in the *West-Indies*. And considering the Hint given us by M. Witzen of its being thought medicinal at Goa, where it is found; and also how that calcined Shells are the most common Entertainments all over the Indies, chewing them all Day long, with the Leaves of a certain hot, piperate and spicy Plant, and a sort of Nut mixt therewith; we may reasonably suspect the *Goa Stone* to be made up of them, or such like Ingredients.

Shining
Worms in
Oysters, by
M. Auzant,
n. 12.p. 203

LXIII. 1. M. Auzant, at the Intimation of M. de la Voge, observed a shining, clammy Moisture in *Oysters*, which stuck to the Shell, and being drawn out, shone in the Air its whole Length, which was about 4 or 5 Lines, and being put upon the Observer's Hand, continued to shine there for some time. And afterwards causing more than 20 Dozen of *Oysters* to be opened in the Dark, he found this shining Substance to be really *Worms* (as M. de la Voge had thought them before) and those of 3 sorts; one sort was whiteish, having 24 or 25 Feet on each side, forked, a black Speck on one side of the Head, taken by him for a Chrystalline, and the Back like an *Eel* stript of her Skin; the second was red, and resembling the common *Glow-Worm*, found at Land, which folds upon their Backs, and Feet like the former, and with a Nose like that of a Dog, and one Eye in the Head; The third sort was speckled, having a Head like that of a *Soal*, with many Tufts of whitish Hair on the Sides of it.

2. The Observer also saw some much bigger, that were Grayish, with a big Head, and 2 Horns on it, like those of a Snail, and with 7 or 8 whitish Feet: But these, though kept by him in the Night, shined not.

3. The 2 first sorts are made of a Matter easily resolvable ; the least shaking or Touch, turning them into a Viscous and Aqueous Matter, which falling from the shell, stuck to the Observer's Fingers, and shone there for the space of 20 Seconds ; and if any little Part of this Matter, by strongly shaking the shell, did fall to the Ground, it appeared like a little piece of Flaming *Brimstone*, and when shaken off nimbly, it became like a small shining Line which was dissipated before it came to the Ground.

4. This shining Matter was of different Colours ; some whitish, some reddish, but yet they both afforded a Light, which appeared a *Violet* to this Observer's Eye.

5. He observed among them 2 more firm than the rest, which shone all over ; and when they fell from the *Oyster*, twinkled like a great Star, shining strongly, and emitting Rays of a *Violet Light* by turns, for the space of 20 Seconds. Which Scintillation the Observer imputes to this, that those Worms being alive, and sometimes raising their Head, sometimes their Tail, like a *Carp*, the Light encreased and lessened accordingly ; seeing that when they shone not, he did, viewing them by a Candle, find them dead.

6. Forcibly shaking these *Oyster-shells* in the Dark, he sometimes saw the whole Shell full of Lights, now and then as big as a Fingers end, and abundance of this clammy Matter, both red and white, which he judges to have been *Worms* burst in their Holes. And in the shaking he saw all the Communications of these little Verminulous Holes, like to the Holes of Worms in Wood.

7. In more than 20 Dozen of *Oysters*, he took no Shell (10 or 12 excepted) but it emitted Light ; and he found some of this Light in 16 of the *Oysters* themselves.

8. This Light occurs more frequently in big than small *Oysters* ; in those that are pierced by the Worm, oftner than those that are not : and rather upon the *Convex Side* than the other ; and more in fresh ones than in the stale.

9. Having somewhat scaled the *Convex Side* of the Shell, and discovered the Communication of the Holes, wherein the often mentioned viscous Moisture that has any Form of Insects is found, he smelt a Scent that was like the Water of a squeezed *Oyster*.

10. The *Worms* give no Light when irritated, but if they do, the Light lasts but a very little Time ; whereas that which appears in those that were not angred before, continues a great while ; the Observer affirming to have kept of it above two Hours.

LXIV. The *Pearl shells* in *Norway*, and elsewhere, do breed in sweet Waters. Their Shells are like to those, which commonly are called *Muscles*, but they are larger. The Fish in them looks like an *Oyster*, and it produceth a great Cluster of Eggs, like those of *Craw-fishes*, some white, some black, (which

The Origin of Pearl, by M. Christopher Sandius, n. fol. p. 11.

(which latter will yet become White, the outer black Coat being taken off; these Eggs when ripe, are cast out, and being cast out, they grow, and become like those that cast them. But sometimes it happens, that one or two of those Eggs stick fast to the sides of the *Matrix*, and are not voided with the rest. These are fed by the *Oyster* against her Will, and they do grow, according to the Length of Time, into Pearls of different Bignesses, and imprint a Mark both in the Fish and the Shell, by the Situation, conform to this Figure.

This Account I received from a *Dane*, called *Henricus Arnoldi*, an ingenious and veracious Person, having by his own Experience found it so at *Christiana* in *Norway*, and with great Seriousness assured me of the Truth thereof.

*Pearl-fishing
in Ireland;
by Sir Rob.
Medding, n.
198. p. 659.*

LXV. There are 4 Rivers in the County of *Tyrone*, abounding with that sort of *Muscles*, wherein Pearls are found, all emptying themselves into *Lough Foyle*, whereon stands the Town of *Derry*, and so into the Sea. There are also other Rivers in the County of *Donesgall*, a River near *Dundalk*, the *Shure* running by *Waterford*, the Lough called *Lough Lean* in *Kerry*, which afford the like Fish; and no doubt, there be many more that I do not know.

In the warm Months before Harvest is ripe, whilst the Rivers are low and clear, the poor People go into the Water, and some with their Toes, some with wooden Tongs, and some by putting a sharpened Stick into the opening of the Shell take them up, and although by common Estimate not above one Shell in an hundred may have a Pearl, and of these Pearls not above one in a hundred be tolerably clear, yet a vast Number of fair merchantable Pearls, and too good for the *Apothecary*, are offered to Sale by those People every Summer Affize. I my self saw a Pearl bought for 50 *Shill.* that weighed 36 *Carats*, and was valued at 40 *l.* and had it been as clear as some others produced therewith, it would certainly have been very valuable. And a Miller took a Pearl, which he sold for 4 *l.* 10 *Shill.* to a Man that sold it for 10 *l.* to another, who sold it to the late Lady *Glenanly*, for 30 *l.* with whom I saw it in a Necklace, she refused 80 Pound for it from the late Dutchess of *Ormond*. The young *muscles* never have any Pearl in them.

The Natives, though very foul Feeders, will not eat the Fish; which seems to me to cut like the *Oyster*, blackish green. The Shell is fastened with 2 Tendons, one at each end, whereas the *Oyster* and *Scallop* are with one only in the Middle. They lie in Part opened, putting forth their white Fins, like a Tongue out of the Mouth, which directs the Eye to them in the Water, being otherwise black as the Stones in the River. The Backs of the Shells, just about the Hinges, on which the *Valves* do open, are all broken and bruised both young and old, and shew the several Crufts and Scales that make the Shell; and is caused (I think till I know better) by the many great Stones that are driven over them by the Floods from the Neighbouring Mountains, which are most impetuous
after

after any little Rain, The insides of the shell are of an *Oriental* and *Pearl* Colour and Substance, like a flat *Pearl*, especially when first opened ; and I was told by an ingenious Person, living upon the Place ; that he had observed in some shells under the first Coat a Liquor that was very *orient* and *clear*, that would move upon the Pressure of the Finger ; but that such a *Muscle* never had *Pearl* ; which Liquor I should think was the true *mother* of *Pearl*.

The Part where the *Pearl* lieth is in the *Toe*, or lesser end, at the Extremity of the Gut, and out of the Body of the Fish between the two *Finni*, or Skins, that line the Shell. I believe that this *Pearl* answereth to the Stone in other Animals ; and certainly like that encreaseth by several *Crusts* growing over one another, which appeareth by pinching the *Pearl* in a *Vice*, the upper Coat will crack and leap away ; and this Stone is cast off by the *muscle*, and avoided as it is able ; and many shells that have had Pearls in them, are now found to have none, which will appear in these Instances : the shells that have the best Pearls are wrinkled, twisted, or bunched, and not smooth and equal, as those that have none. And the crafty Fellows will guess so well by the shell, that though you watch them never so carefully, they will open such shells under the Water, and put the Pearls in their Mouths or otherwise conceal them. Yet sometimes when they have been taking up shells, and believing by such signs as I have mentioned, that they were sure of good Purchase, and refused good Sums for their shares, they found no *Pearl* at all in them. Upon Discourse with an old Man that had been long at this Trade, he advised me to seek not only when the Waters were low, but in a dusky gloomy Day also, lest, said he, the Fish see you, for then he will shed his *Pearl* in the Sand ; of which I believed no more, than that some *muscles* had voided their *Pearls*, and such are often found in the Sand.

I conceive that these Pearls if once dark, will never be clear upon any Alteration in the health or age of the *Muscle*, or of the Moon ; and that if the first Seed be black, all the Coats superinduced will be still *clouded*.

The bottoms of these Rivers I observed to be part *sandy*, part *stony*, and part *oozy*. Many of these *muscles* lie in brackish Water ; being driven down the Rivers 4 or 5 Miles within the Flowing of the Sea. I have sometimes observed the same *Pearl* clear at one end, and dark at the other.

LXVI. *Pectinem* nactus, ineunte *Januario*, ejus Dissectionem, qua potui ^{The Anato-} accurratione, certe ex uno exemplari, institui. Imprimis vidi *Cardinem* ex ^{my of a Scal-} *Cavata valva* leviter incurvari, & superinjici alteri ac *Plana Valva*, toto ^{lep : By Dr.} que illo latere inter se *Cartilagine* quadam firmiter connecti : Item in ipso ^{M. L'her.} medio spatio *Cardinis* alteram aterrimam robustamque admodum *Cartilagi-* ^{n. 229. p. 557} *nem* disponi. Hinc adeo mira illa Constrictionis vis, & fortasse *Planam Val-* *vam*, Remi alicujus more, movendi, adque pernicitatem, & volatus quan- dam imaginem moliendam : de quo quidem non semel loquuti sunt vete- res tanquam huic *Conchilio* peculiari.

Apertis

Apertis autem *Valvis* hæc conspicienda sese exhibent. Ad *Dextram* & sub *Cardine* *Os* *Cucullatum*, instar *Ostreae*. *Velamina* autem *Oris* conficiuntur ex *Concursu Branchiarum Exteriorum*, quæ *musculosæ* sunt, totumque *Animal* à *capite* ad *Ani* exitum, scilicet *sinistram* versus e regione *oris*, ubi inter se rursus connectuntur, circumambiunt.

Ex isto autem pari *branchiarum* exteriorum, ea, quæ *planæ Valvæ* incumbit, *Centro* suo adhæret superiori *Limbo* ingentis cujusdam *musculi* *Rotundi*, qui ex *Rectis Angulis* in *Mediis Valvis* inseritur: Altera vero exterior *Branchia* similiter conjungitur alteri capiti ejusdem *Musculi Centralis*.

A *Musculo* vero *Centrali* ambæ istæ exteriores sive *Spuriæ Branchiæ* e tenui *membrana* & pellucida admodum constant; Et ad medias *Valvas* expansæ, leviter iis adhærent, ut moveri inde non possint, tumenturque *animalis Dorsum* ab aquæ injuria, intra *Valvas* receptæ; a loco vero istius adhæisionis, crassus quidem *musculus* mirificus, tanquam limbus, incipit. Is autem a me depingitur tantum eo quo contrahitur modo; sed in *vivis* mire extensilis est, etiam longe ultra *marginés valvarum*. Item *Laciniis* donatur, & ex *Rufa* variatur *Lineolis* elegantissimis. Multis autem diebus a *Piscatione* nostri *Pectinis* is *Limbus* haud obscure movebatur. *Usum* autem ejus sic intelligo, nempe ex *Contractione* incurvata introrsum, more retis cujusdam, cum ambo isti *Branchiati musculi* extra *Conchas* emissi sint, quicquid intra se complexi fuerint, sibi mutuo adpliciti, ad se rapiunt in *viſum animalis*: *Laciniis* autem, extremis suis marginibus tenuiter incis, *Aqua marina* separari videtur retento cibo. Si qui vero sint alii ejusdem *Partis Usus*, me latent. Illud tamen addere lubet, hunc *Limbum* posse inservire etiam *Necationi* cujuscunque *Animalis* minuti aut *Pisciculi*, ex forti compressione; itemque ex *motu undulatorio*, qui in eo valde notabilis est, posse circumferri victum; eumque tandem, quacunque parte *Circuli Retiarii* sit, ipsi *Ori* exporrigi, ita *manus locum* quodammodo supplet.

Ad veras autem, certe quæ ita appellari solent, *Branchias* venio, hæc vero quatuor sunt leviter *Flavicantes*, atque *Pectinatim* striantur eleganti quodam opere. Illæ autem *Branchiæ Musculum* magnum *Centralem* circumambiunt, interque se comprehendunt sive incumbunt *Utero*, ejusque *Ovaris*, certe *Partibus Generationi* dicatis. Harum autem *Partium Figuræ* recte a me ante delineatæ fuerunt, & jam *vivo* quoque *Animali* video ejus partem inferiorem ex *Croco* resplendere; Superiorem vero *albicare*; juxta *Os* vero *Processus* quidam *Duplici Foramine* apertus, conspiciendus est. Horum autem *Foraminum unum*, *Vulvæ* Exitus existimandus est; & si *Androgyni* sint *Pectines* (quod suspicor ex perpetua similitudine istius *Partis* in omnibus a me visis, & vivo & Conditis) *Alterum*, ad *Maris* *Genitale Membrum* exerendum instituitur.

Ad *Caput* procedo; Huic *Os Labiis* circumscriptum est *Rufescentibus*, more *Branchiarum* internarum; & brevibus admodum, & in nostro Exemplari crispis, forte vitiosis & mutilatis. Sub ipsum vero *Cardinem* medium duo prægrandes veluti *Circuli* sive *Cavitates* instar *Oculorum* (ut *oculi* non sunt) alicujus *Rhombi* *Piscis*, oblique positorum.

Os vero Caputque excipit Majusculum Meconium Subnigrum, ad sinistram vergens. Pone id Cor latitat, perque ipsum Pericardium Pellucidum conspici potest; ex carneo leviter Rufescit. Cordis Aorta in Branchias disperitur. An vero id solum Pericardium sit quod scilicet proxime adjacet Nigro Meconio, sive totum etiam illud Figura Rhomboide comprehensum, hæreo. An pars ejus inferior Vesica Urinaria sit, quæro: Certe ex Meconio oritur Intestinum Rectum, superque Pericardium equitans, ad internas Branchias pro- tenditur & Musculo Centrali adnectitur.

Musculus autem Centralis Orbicularis est, Albus & Lævis magna super- ficiei suæ parte, qua Conchæ adhæret; ex sinistra vero parte, alio Candidiori musculo lacerato distinguitur, & Conchæ magis formatur.

aaa. Os, Caputque, bb. Meconium Aterrimum, c. Cor, prout subter Membra- Explication of the Figure. Fig. 231. nam latitat. dd. Pericardium, an Vesica Urinaria Rhomboides. eeeee. Intestinum Rectum Pericardio super equitans. fffffff. magnus musculus Centralis, g g. alius musculus laceratus Testis fortiter adhærens. bbbb Branchiæ internæ. ii. Uteri prælongati Exitus, duobus Foraminibus distinctus tanquam in Andro- gynis. k k. Uteri pars superior Albida. lll. Uteri pars inferior Crocea, m m m m. Limbus Variegatus, sive musculus Retiarius secundus.

LXVII. There are found on the Coasts of Calabar and Ceylon, certain Cockles or Shells, in Dutch call'd Kouk-borens. These Shells contain a Fish that lives in the bottom of the Sea, fixt in the Body of the Shell, and at a certain Season of the Year, they cast their Seed, which produces a sort of matrix of the size of the Figure. This long Body which is wrinkled like an Andouille, or Sausage, is fill'd with great Number of round Cells, which are so many matrices, each producing its little Shell Fish; which quit not their Cells till they are grown to such a bigness and Maturity, as their Weight breaks them off, and loosens them from their Cells, and so from their common matrix, which remains fastened to the bottom of the Sea by the great End, the other End moving about freely in the Water, which is flexible every way like an Andouille. It is observable that this matrix has a kind of Back-part and Belly; the Back is somewhat like that of a Schelvis, and of a grayish Colour, the Belly is whiter, and is that Part which is fill'd with the Cells from one End to the other: The Skin which covers it is very like that of Stock Fish or other dried Fish.

LXVIII. The Stones in the Heads of Craw Fish are always on the out- side of the Stomach, while the Old Coat sticks on the Back of the Fish, and pass into the Stomach as soon as they cast their Coats; I never saw them on the outside when they have changed, nor within before. I have observed that the males of Craw-fish change their Coats, a consi- derable time before the Females; for they always keep theirs till they have parted with their Young from their Tails.

LXIX. Those

Cancelli,
Soldiers, by
Mr. Will.
Cole. n. 178
p. 1284.

Vid. Sup.
p. LIX.

LXIX. Those who shall seek after the Purple-fish will find, as I have done, some of those shells in which are the *Cancellarii*, or rather *Asiaci*, unto which they are more like, and so may mistake: For those little Crabs, or Craw-Fishes, I have found in most of our *English* shells, excepting the *Bivalved*, and *Patella*?. Of these Fishes in many Parts (especially in the *West Indies*) there are many sorts, and some very large, which our Country-men there call the *Soldiers*; for that they say, they enter by force, kill and take Possession of those Houses they have not built; and when they grow too big, forsake them and enter into larger. Whether that be true, I know not, but this I have found, when I have broken some of the shells in which those *Vagrants* are, so as not to bruise their Bodies, and then put them naked into the Water, I have beheld them with nimble springing Motion, to run to and fro till they find a Stone to hide themselves under; which not finding, they bury themselves in loose Sand. This Observation gave me full satisfaction, that they were not, (at least all the kinds) *Connate* and *Cas-lescent* with their Shells; as other *Testaceous* Animals of the Sea and Land are.

A Stellar-
Fish, by Mr.
Winthorp.
n. 57 p. 115.
n. 74 p. 222.

Fig. 233.

LXX. 1. I understand by the Fisherman who brought me this Fish, that he never saw, nor heard of any but 6 or 7 that were taken at several times by himself, not far from the *Shoals* of *Nantucket* (which is an Island upon the Coast of *New England*) when he was fishing for *Cod*. This *Stellar-fish*, when it was alive, and first pulled out of the Water, was like a Basket, and had gathered it self round like a Wicker-Basket, having taken fast hold upon that *Bait* on the Hook which he had sunk down to the bottom to catch other Fish, and having held that within the surrounding *Brachia*, would not let it go, tho' drawn up into the Vessel; until by lying a while on the Deck, it felt the want of its Natural Element, and then voluntarily it extended it self into a flat round Form. The only use that could be discerned of all that curious Composure wherewith Nature had adorned it, seems to be, to make it as a Purse-net to catch some other Fish, or any other thing, fit for its Food; and as a Basket of Store to keep some of it for future supply; or as a *Receptacle* to prepare and defend the young ones of the same kind from Fish of Prey, if not to feed on them also (which appears probable the one or the other;) for that sometimes there were found pieces of Mackarel within that Concave: and he told me, that once he caught one, which had within the *Hollow* of its Embracements a very small Fish of the same Kind, together with some piece or pieces of another Fish, which was judged to be of a Mackarel.

He told me that every one of the smallest Parts had Motion when it was alive, and a tenacious Strength; but after it was dead and extended to a flat Round, it was so brittle that it could not be handled without breaking some Parts of it; but by carefully laying it to-dry, it was somewhat hardened. I think (till a fitter *English* Name may be found for it) that it may be call'd a *Basket Fish* or a *Purse-Net-Fish*.

2. This

2. This elaborate Piece of Nature, we may call *Piscis Echino Stellaris Vi.* By ———
seiformis, its Body (as was noted by Mr. Hook) resembling an *Echinus* or *Egg-fish*, the main Branches, a Star, and the dividing of the Branches, the Plant
Missel toe. This Fish spreads it self from a *Pentagonal Root*, which encom- Fig. 233.
 passeth the Mouth (being in the middle, at *a*) into 5 main Limbs, or Branches;
 each of which, just at the issuing out from the Body, subdivides it self in-
 to two (as at *i*.) and each of those 10 Branches does again (at 2.) divide in-
 to two parts, making 20 lesser Branches: Each of which again at (3.) di-
 vide into two smaller Branches, making in all 40. These again (at 4.) into
 80; and those (at 5.) into 160; and they (at 6.) into 320. They (at 7.)
 into 640; at 8, into 1280; at 9, into 2560; at 10, into 5120; at 11, into
 10240; at 12, into 20480; at 13, into 40960; at 14, into 81920; be-
 yond which, the farther Expanding of the Fish could not be certainly
 Traced, though possibly each of those 81920 small Sprouts or Threads, in
 which the Branches of this Fish seem'd to terminate, might, if it could have
 been examined when living, have been found to subdivide yet farther. The
 Branches between the Joints were not equally of a length, though for the
 most part pretty near; but those Branches, which were on that side of the
 Joint, on which the precedent Joint was placed, were always about a 4th, or
 5th part longer than those on the other side. Every of these Branchings
 seem'd to have, from the very Mouth of the smallest Twigs or Threads, in
 which it ended, a double Chain or Rank of Pores, as appears by the Figure.
 The Body of the Fish was on the other side, and seem'd to have been pro-
 tuberant, much like an *Echinus*, or *Egg-fish*, or *Buttson-fish*, and like that
 divided into 5 Ribs or Ridges, and each of these seem'd to be kept out by
 two small bony Ribs. NS. In the Figure is represented fully and at length,
 but one of the main Branches, whence 'tis easie to imagine the rest cut off
 at the 4th Subdividing Branch; which was done to avoid Confusion.

3. This Star-fish is the *Stella Arborefcens Rondeletii*; First described by By Mr. Fran.
 him, and since by other Naturalists. Willoughby.
 n. 58. p. 1100

LXXI. 1. In Decem. 1696. Two remarkable Marine Animals were found A Scolopen-
 in the Stomach of a common Cod Fish sold in the Fish Market in Dublin. dra Marina,
 One of them by lying long in the Stomach was much mangled and in part by Dr. Tho.
 digested: But the other was compleat in all its Parts, and had received Molineux.
 no manner of Alteration, save 'twas dead. It was bigger at one End, n. 125. p. 405.
 and went taper or gradually lessening towards the other. It was 4 1/2 Fig. 234, 235.
 Inches long; and where largest, as it was 1 1/2 broad, so it was about 3 1/2
 Inches in Circumference: At the smaller End, not above 1/4 of an Inch
 broad. It had neither Shell, Crust, Scales, or Bone, for its Covering, but
 was soft: Yet not Flabby or Flethy, as the *μαλακία*, or *Mollia*, but rather
 Membranous.

The Back or upperside, was shaped roundish, especially towards the sides;
 in the middle it was something flattened; the Belly was perfectly Plain. Fig. 234.
 Along the middle of the Back ran a large Stripe from one extreame to the o-
 ther,

ther about $\frac{3}{4}$ of an Inch broad, towards the upper End, but still narrower as it came towards the Tail. This *Stripe* was all covered with a short soft sort of *down*, not unlike in Texture, Colour, and Substance, to that which grows on the *back* of the *Leaf* of *Tussilago* or *Colts-foot*. Joining to the Edge of this *Stripe*, ran from one end to t'other, a Lift about $\frac{1}{2}$ of an Inch broad, that covered both sides of the Animal, and part of his *back*. This Lift or Verge, was thickly shagged, with a fine soft Hair that was very *thick* and about $\frac{1}{4}$ of an Inch long, of a most delicate changeable red and green Colour, and of so sparkling and vivid Lustre, that nothing of this kind could shew more Beautiful. Among this soft Hair were thickly interspersed without order, an abundance (some *Hundreds*, I believe) of black, sharp, hard Prickles, about the Length of the Hair, and the thickness of a *Hog's Bristle*, but much harder, and very sharp at the Points. The Tail, or smaller end terminated in the *back*, with two *Triangular* pellucid soft *Seals* that covered the Orifice of the *Anus*, at which its Excrement was discharged, as I found when I opened it, for the Extremity of the *Intestine* was closely inserted into this Passage.

Fig. 235. The bigger end, though it had not any *Horns*, *Eyes*, *Ears*, *Nose*, or *Gills*, yet because it was opposite to the *Tail*, and here was the Mouth, we may properly enough call the Head. The Mouth was a very large parulous Opening for the *bulk* of the *Animal*; not placed at the end, but somewhat underneath, as part of the *Belly*, and could not be seen when the *back* was turned uppermost. The *Belly* was flat, and no ways protuberant, covered with a smooth naked Skin, of a much lighter Colour than the *back*, irregularly spotted, with little dark brownish Spots, some larger some smaller: 'Twas broader towards the Head, and grew narrower still towards the Tail; where for above the space of an Inch, it was curiously pinched with little *Indentures*, resembling the small Joints in the *Tail* of some *Insects*. These *Divisions*, or Joints, were still shorter and closer to one another, the nigher they were to the Extremity of the *Tail*. Beginning close at each Corner of the Mouth, and so along both sides of the *Belly*, was ranged a Row of Feet, in a close continued Series down to the utmost tip of the *Tail*. The largest were placed towards the Mouth, and upper Part of the Body, where they were about a quarter of an Inch long; but *downwards* they grew less and shorter, still gradually diminishing, the nearer they approached the end of the *Tail*; where they were so minate, that they were insensibly lost, and not easily to be distinguished by the *Eye*. I distinctly counted from the Mouth to the Tail, on one side 36, and I could not be positive but there might be still more. From within the Body, thro' the middle of each Foot pass'd 4, 5, or 6 of the same sort of sharp hard Prickles, that were interspers'd amongst the soft Hair. These were larger or smaller, and more or less in Number, according to the size of the Foot, and give it strength and firmness instead of *Bones*: And likewise issuing forth beyond the end of the Foot serves in lieu of *Toes*, or *Claws*. Joining to this Row of Feet, towards the *back*, was ranged along each side in a direct Line, a Series of small thin, soft, flat

flat Fins, Face to Face in such an Order, that each *Foot* was exactly answered by its correspondent Fin : so that their Number was precisely the same with that of the *Feet*, and they kept the same Rule of Proportion of their Size, still gradually diminishing the nearer they approached towards the *Tail*. I distinctly counted of these, as of the *Feet*, 36 of a side ; each Fin was curiously fringed at the Edge, with the same Beautifully Coloured Hair, I before mentioned to have covered the Sides and part of the Back. By help of these *Fins* it performed *Progressive* Motion through the Water as a Fish ; and by means of the *Feet* could creep along the bottom of the Sea, as a *Reptile*.

When I open'd it, I found a thin *membraneous Gullet*, that led from the Mouth to the Stomach, about an Inch long. From this was continued straight downwards the Stomach, of a whitish Colour, and of a tough thick Texture, consisting of an outward and inward *Membrane*, with a sort of *Carneous* Substance between ; resembling somewhat in Make, tho' not in Figure, the *Gizzard* in some *Fowl* ; 'twas as large as the upper Joint of a Man's little Finger. To this was annexed the *Intestine*, of a very differing Colour and Substance from the *Stomach* ; for 'twas reddish, soft and tender, and of a much smaller Cavity ; 'twas continued almost directly, or with little Circumvolution, to the *Anus*. The *Brains*, *Heart*, *Gills*, *Liver*, or *Parts* for *Generation*, (if they have any) were hardly, if at all, to be distinguished.

The Muscular Parts were very curious, large and distinct. One long continued *Stripe* of *Red Fleshy Fibres*, about the sixth Part of an Inch broad, ran directly along the middle of the *back*, from the Head down to the *Tail*. This *Fleshy Stripe* sent out from each side, like so many *Rays*, 36 several Pair of smaller lateral Muscles, which, by the considerable Interstice between, I could easily distinguish from each other ; making so regular a Figure all together, that they might very aptly be resembled to the *Spine*, or *Back-bone*, of the *Passer Marinus*, or common *Plaie* Fish, when it is entire with all its *Ribs*, or *Transverse Processes* issuing by *Pairs* from both sides of each *Vertebra*, from the Head down to the *Tail*. In this manner every particular *Foot* and *Fin* were supplied with their correspondent Muscles, to give them Motion, either together or apart, as the Necessity or Design of the Animal required. And moreover, considering this sort of Muscular Mechanism, with the Taper shape of the Body, and likewise the Posture and use of the many *Prickles* interspersed among the *Hairy Shag* that covered the sides ; it seems very evident to me, that besides its *Progressive Motion*, it had also the Power, (as have most of the Many-footed Land *Reptiles*, and some *Water Insects* I have observed) of Contracting its Body, in such a way, that bending its Head inwards, it roll'd the rest of the Body round it as a Center, making a Figure like a *Rope* coil'd into a *Helix* ; and in this Posture, beset almost quite round with *Sharp Prickles* starting out directly forward, it guarded it self from Violences that might annoy it.

This Animal, on many Accounts, I think may properly be ranged with the *Scolopendra Marina* described by *Rondeletius*; but it may be distinguish'd from them, by calling it *Scolopendra Marina a Capite Latiori versus Caudam sensim gracilescens, Limbo Pulcherrime Hirsuto Spinulisque crebris interstincta e Mari Hibernico.*

Replication
of Figure.
234. and 235.

a a a a a. The Downy List that runs along the Back; *bb* the two Triangular Scales that cover the Anus; *cccccccc* the Verge of fine Changeable Green and Red Hair that covered the sides, and part of the Back; *d d d d d d d d* the hard sharp Prickles interspersed among the Hair; *eeeeee* the Skin of the Belly; *fffff* several Incisures resembling Joyns towards the Tail; *gggggg* Darker Spots in the Skin of the Belly; *h h h h h* the Feet of each side the Belly; *IIIIII* the Fins with their Hairy Fringe behind the Feet; *k k* the large Mouth opened wide.

By Mr. Dill.
n. 254 p. 51.

2. I observed at *Harwich* in 1698. divers of these Marine Animals brought up by the Fishermen, which they call *Sea-mice*: They are described by *Rondeletius*, and by *Mouset* and *Johnson* (Figured under the Title of *Physalus*) but badly.

By Dr. Mor-
lyneux, n.
251. p. 127.
de Piscibus,
L. 15. p. 425.

3. I think, if we'll suppose that *Rondeletius* saw what he describes under the Title of *Physalus*, we can't imagine that he and I had the same Object before us. This will appear evident by comparing his Words with mine: For he says of his Animal, *Ore caret*; whereas I say, the Mouth of mine was a very large Patulous Opening for the Bulk of the Animal: He says, *In Medio latior est & extrema gracilescunt, Pudendi Muliebrii speciem referens*; whereas I say, 'Twas bigger at one end, and went taper, or gradually lessening, towards the other: he says, *In Dorso tumores parvi eminent, Verrucas Piscatores nostri vocant*; I am sure I could observe none such, but say, The Back was covered with a short soft sort of Down, in Colour, Texture, and Substance like that which grows on the Leaf of *Tussilago*: *Venenatum experiri sumus*, says he, whereas I found two of the *Scolopendra's* I described in the Stomach of an Animal that had devoured them, and digested one as its Natural Food and Sustenance, from whence we may conclude that they are not Poysonous; and besides *Rondeletius* his Icon agrees exactly with his own Description; whereas it neither agrees with my Description nor my Figure.

Vol. 3. p. 87

But I have lately, in the *Atta Med. & Phil. Hafn.* of *Tho. Bartholini*, met with the Figure of a *Sea-Insect* under the Name of *Vermis Aureus vel Species Brucæ Marinae rarior*, which I am confident is the same with mine; tho' *Bartholini's* Figure is faulty, and the Description short, false and imperfect.

De Insect. L.
5. Cap. 15.

And I am apt to think that *Ulysses Aldrovandus* design'd our *Scolopendra* by the *Scolopendra Marina Lato Corpore Subcastaneo velut Pedibus immixtis longiusculis Aurei Coloris*; though his Icon be much worse than *Bartholini's*, and requires some Strength of Phancy, to guess whether it be really so or not.

LXXII. At Sir *Just. Isham's*, I lately saw 4 very large *Carp*s that a Boy took with his Hands in the Heat of the Day : His Way was this, he waded into the Pond, and then returning to the Sides he would grope them out in the Sedge or Weeds, and tickling them with his Fingers under the Belly, quickly removed his Fingers to the Gills, and threw them out upon the Land ; and this he did not in a narrow, but large Pond, of about an Acre of Ground. He knows when he is upon the *Carp*s Layer, if I may use that term, by the Warmth of the Water, and then he immediately repairs to the Sides to pursue his Game.

I may here note, that *Carp*s, and I suppose, all other Fish that keep near the Bottom, keep always in a *Shoal*. And when they move from one place to another, they raise the *Mud* in the Heat of the Day ; so that you may easily observe, what Road they travel, by a muddy Tincture near the bottom of the Water ; and that so certainly, as you cannot easily miss of covering the greatest part of them with a *Cast-net*.

LXXIII. From *Lampport* towards *Bridgewater*, *Eels* are so cheap in the Frosts of *Winter*, that they vend them for little. Their Abundance is from hence, that as the People walk in the Frosty Mornings, on the Banks of the River, they discern towards the edges of the Banks, some Parts not hoar, as the rest, but green ; where searching the Holes of the Banks, they find heaps of *Eels*.

LXXIV. I have lately met with Relations of two very large *Eels*, caught upon the Coast of *Essex*, they both had all the *Characterising Notes* of the *Eel*, and wanted those *Barbles* which the *Eel* sometimes hath not, but the *Conger* is never without. The first was taken somewhere about *Cricksea* : Its Length from the Tip of the Nose to the Tail's end, was 5 Foot 8 Inches ; and in Circumference it was 22 Inches. The other was taken in *Maldon Channel*, about a Mile below the Town : the Length of which was 7 Foot : the Circumference 27 Inches, the Weight 36 Pounds, and out of its Belly was taken 5 Pounds of Fat ; its Skin was black, and being stuffed, is still preserved at *Maldon*. This Fish was supposed to have been brought down thither by the great Floods, at the breaking of the last Frost, because of a Hurt it had on its Back, which the Fisherman who caught it, told me he did conjecture might be from some Mill it must pass through.

LXXV. 1. The Reason of the Difficulty of discovering the manner of the Generation of *Eels*, is the different Way of Generation, and that they breed in February, a time when few are taken but what are preserved in Trunks or Ponds, where they breed not. This I examined 2 Years since, in some taken at a Mill, in which Holes they breed, especially near gravelly Shallows ; and found one with Egg, another with 6 young ones, in the great Intestine, which

which I call the *strait Bowel* that descends immediately from the *Pylorus*, until the Winding begins. They were fastned to very small *Placenta* each, which was fixed to the *Intestine*; the *Meferaicks* at that time were very turgid. The Eggs were on the Outside of the *Intestine*. It is certainly viviparous and feeds not, at least gross in the Winter; during all which, they lie still till they have discharged their Young. The Parts distinguishing the Sex are discoverable; those of the Male affix to the Extremity of the *Kidney*; the Female had a slender *Gland* transversly lying near the *Bowel*; but of this I dare not say much.

In *Salt-Water-Eeles*, I have not found the like, though search'd for; because I am of Opinion, they do not breed, but are the same with the *Fresh Water* ones, since such Multitudes of fresh Water Eels go down to the Sea, and cannot return, yet are never taken at Sea, among the many brought hither: and there are *Vestigia* of their Beards in the fresh Water Ones.

By Mr. Dak,
n. 238, p. 92.

2. That the Generation of any Animal cannot be Equivocal or Spontaneous but from animal Parents, hath been so well by many undeniable Arguments asserted, and by multiply'd Experiments confirmed, by those famous and celebrated *Virtuosi*, *Malpighius*, *Redi*, *Swammerdam*, *Leeuwenboeck*, *Mr. Ray*, and others, that I think there is no Room to doubt but that *Eels* have the same Original: But it is much disputed amongst the Learned Naturalists whether *Eeles* have distinct Sex, or are *Hermaphrodites*. *Mr. Allen* affirms, the Parts distinguishing the Sex to be discoverable, but *Mr. Leeuwenboeck* could never find any such thing; for all those that he hath dissected, he declares, were provided with an *Uterus*: from whence he doth conjecture them to be *Hermaphrodites*, and besides the *Uterus*, to be provided with *Masculine Seed*.

Another Controversy about the Generations of *Eeles* is, whether they are Oviparous or Viviparous.

I find many ingenious Persons, who firmly believe them to be Oviparous; but their Sentiments are contrary to the Observations of *Walter Chetwynd*, Esq; who in the Month of *May*, found them to be Viviparous, by cutting open the red Fundaments of the Females, from whence the young *Eeles* would issue forth alive.

And although *Mr. Allen* affirms them to be certainly Viviparous, yet his Observations concerning the Place of their Conception, I cannot conceive to be consonant to that Care and Industry of Nature, in providing convenient Receptacles for preserving the *Fetus*; neither is it agreeable to Reason to believe, that when Nature hath provided an *Uterus* in all Animals, not only the Viviparous, and such as only cherish the *Embryo* in *Utero*, but in the Oviparous also and Insects; the *Eel* and *Xipbia*, or *Swor-fish*, should be the only Animals without it; much less that the Guts, appointed by Nature, for the Secretion of Nourishment, and the Expulsion of the *Feces*, and are always in Motion, should be the Place

of Generation in any Animals, though we may allow *Eels* not to feed Gross in the Winter. On the contrary, that the *Eel* hath an *Uterus*, is asserted by Mr. *Leeuwenhoeck*, who never found them without; which perhaps is that Part which Mr. *Allen* names a slender *Gland*, transversely lying near the *Bowel*.

Besides, Nature having in all Animals, *Oviparous* as well as *Viviparous*, hitherto dissected, provided not only an *Uterus*, but also *Tubes* (first observed by *Fallopium*) for the conveying the *Ovum* from the *Ovarium* to the *Uterus*, another great Difficulty and Objection lieth against Mr. *Allen's* Observations; and in which indeed he seems to contradict himself; for whereas he saith, that in one *Eel* he found Eggs, and those on the outside of the *Intestine*, but in the other, 6 young Ones, each fastened to a small *Placenta*, and those within the great *Intestine*, how and by what Passages could those Eggs come into the great *Intestine*; to be formed and invigorated, unless we may suppose they do, like the *Embryo's* of some sort of Insects, which for the Convenience of Food eat their own way into their *heterogeneous*, or assumed *Matrices*?

LXXXVI. In April 1669, at West-Chester, I met with a young *Porpus*, caught upon those Sands. The length was 3 Foot 7 Inches; a string of 2 Feet and 2 Inches, girded him in the thickest place; the shape of his Body was not much unlike that of a *Tunny fish*, only his Snout longer and sharper, his Skin was thin, smooth, and without Scales; in an old and well grown Fish, it's like the Skin may be thick and tough, as *Rondeletius* represents it. His Fins are cartilaginous, and flexible, not sharp or prickly, as the Ancients report them. On his Back he hath only one, which was distant from the tip of his Snout 1 Foot and 9 Inches, and the Basis of it is in length $5\frac{1}{2}$ Inches; so that measuring from the tip of his Snout to the end of his tail, it was situate somewhat below the Middle of the Fishes length. On the Belly it had only 1 pair of Fins, $9\frac{1}{2}$ Inches distant from the tip of the lower Mandible, much about the Place where the foremost pair of Fins in other Fishes usually grow. The Tail is forked, of the Figure of a *Crescent*, the Breadth thereof from Angle to Angle 11 inches; and the Plain of it lies parallel to the *Horizon*, as in all others, I suppose, of the *Cetaceous Kind*; the Reason whereof I conceive to be partly to supply the use of the hindmost pair of Fins in other Fishes, which serve to balance the Body, and keep it up in the Water; and partly to facilitate the Fish's Ascent to the top of the Water, to which he can immediately raise himself by a light Jerk of his Tail, thus placed for the use of Respiration, which is necessary for him.

For doubtless, if violently detained under Water, he would in a short time be suffocated or drowned. Immediately under the Skin lay the fat, which as I remember, our Seamen call the *Blubber*; it was firm, full of *Fibres*, and in this small Fish of an Inch Thickness, encompassing and enclosing the whole Body, Back, Belly and Sides. The Use whereof I conceived to be, 1. To keep the cold Water at a Distance from the Blood,

which

Observations
on the Anatomy
of a
Porpus, by
Mr. J. Ray.
n. 71. p. 1220.
n. 76. p. 1274.

which is, I believe, actually and to the Touch hot. 2. To keep in the hot Steams of the Blood from evaporating, by that means also preserving and maintaining its natural Heat. 3. Perhaps also, to lighten or counterpoise the Body of the *Fish*, which would otherwise be too heavy to move and swim in the Water. Under the *Blubber* lay the musculous Flesh like to that of *Quadrupeds*, but of a darker Colour.

The Body was divided into 3 *Regions*, or *Ventres*, like a *Quadruped*, viz. *Head*, *Breast*, and *Belly*. The *Vessels* and *Viscera* in each *Venter*, for the main the same as in *Quadrupeds*; the *Abdomen* was encompassed about with a strong *Peritonæum*; the *Guts* joyned to the *Mesentery*, and of a very great Length, by Measure 48 Foot, without any Difference or Distinction of great and small, neither was there any *blind Gut*, or *Appendix*, that I could find; the *Stomach* was of a strange Make, being divided into two large bags, beside other small ones; I found nothing in it, but a good Number of those little long *Fishes*, which our *Fishermen* dig out of the *Sands* at *Low water*, and therefore called in some Places *Sand-Eels*, by some they are called *Launces*, and by *Gesner*, *Ammodytæ*. The *Liver* was of a moderate Size, situate in the Right-side, and divided into 2 Lobes, having no *Cistis Pillea*, or Receptacle of Gall annexed. The *Pancreas* large, sticking close to the 3d. bag of the *Stomach*, into which also it's *Ductus* enters, and empties it self. The *Spleen* was small and roundish: The *Kidneys* large, sticking close to the *Back* and lying contiguous one to the other, made up of many little *Kernels*, like to, but much lesser than those of an *Ox*, of a flat Figure, having no *Pelvis* in the Middle, but the *Ureters* going out at the lower End. The *Urine-bladder* was oblong, and little for the bulk of the Animal, having on each side a round *Ligament*, made of the *umbilical Arteries* degenerating: The *Penis* long, slender, having a small sharp *Glans*; it appears not outwardly, but lies hid in its *sheath* within the body, doubled up, or rather reflected, in the Form of the Letter S. as is that of a *Bull*. The *Testicles* lie within the Cavity of the *Abdomen* on each side, as they do in an *Hedge-bog*, and some other *Quadrupeds*, of an oblong Figure; for their internal Substance, *seminal Vessels*, both *Præparantia* and *Deferentia*, *Epididymides*, *Vas Pyramidale*, *Corpus Varicosum*, and *Glandulæ Prostatæ*, exactly like to those of *Quadrupeds*. The *seminal Vessels* perforate the *Urethra* with many little Holes, whereof 4 are most conspicuous, somewhat above the Neck of the *Bladder*.

It had six short *Ribs* that had no *Cartilages*, and seven that had *Cartilages*, on each side, I mean. The *Breast-bone* was very small, the *Diaphragm* was Musculous, as in *Quadrupeds*. The *Heart* large, included in a *Pericardium*, had its two *Ventricles*, its *Valvulæ Sigmoides Semilunares Tricuspidæ & Mitrales*, its *Coronary Arteries* and *Veins*; in a Word, the whole Structure and Substance of the *Heart* and *Lungs* agreed exactly with that of *Quadrupeds*. The *Wind-pipe* was very short, as it must needs be, the *Fish* having no Neck, the *Larynx* at top was of a singular Figure, running out with a long Neck, and a Nob at the End like an old fashioned *Ewer*.

The *Pipe* in the Head, through which this kind of Fish draw their Breath, and spout out Water, lies before the *Brain*, and ends outwardly in one common *Hole*, but inwardly it's divided by a *bony Septum*, as it were, into 2 *Nostrils*; but below again it opens into the Mouth in one *Hole*. This lower Orifice is furnished with a strong *Sphincter*, whereby it may be shut and opened at Pleasure, and above this *Sphincter* the sides of the *Pipe* are lined with a *glandulous Flesh*, which if you press, you will see start out of many little *Holes*, or *Papilla*, into the Cavity of the *Pipe*, a certain *glutinous Liquor*. Above the *Nostrils* is a strong *Valve* or *Membrane*, like an *Epiglottis*, which serves to stop the *Pipe*, that no Water get in there against the Fish's Will. Within the *Fistula* are 6 blind *Holes*, having no Outlet: 4 tending toward the *Snout*, 2 above the *Valve* that stops the *Nostrils*, and 2 beneath it, and 2 tending towards the *Brain*, having a long but Narrow Cavity for the use of smelling, as I conjecture, tho' opening the *Brain*, I could find neither *Olfactory Nerves*, nor *Processus mammillares*.

The *Eyes* are small considering the Bigness of the Fish, and situate at a good Distance from the *Base* of the *Brain*; the *Snout* is long, and furnished with very large *Muscles* to root or turn up the *Sand* at the bottom of the Sea for to find Fishes, as appears in that we found nothing in his *Stomach* but *Sand-Eels*, which, as was intimated before, lie buried in the *Sand*. The *Brain* and *Cerebellum* are, for the Substance and *Anfractus* of them, the same with those of *Quadrupeds*, only differing in the Figure, as being Shorter; but what they want in Length, they make up in Breadth. They have also the like *Teguments* called *Dura* and *Pia Mater*; six or seven pair of *Nervis*, besides the *Optick*; the same *Ventricles*, only in the *Medulla oblongata* we observed not those Protuberances called *Nates* and *Tubus*. The *Skull* (*Cranium*) it not so strong and thick as in *Quadrupeds*; but articulated after the same Manner to the first *Vertebra* of the Back-Bone. This Largeness of the *Brain*, and Correspondence of it to that of Man, argue this Creature to be of more than ordinary Wit and Capacity; and make to seem less fabulous and improbable those ancient Stories related by *Herodotus*, *Pliny the Elder*, and *Pliny the Younger*.

In each Jaw it had 48 Teeth, standing in a Row like to little blunt Pegs, the *Tongue* was flat, above an equal Breadth to the very tip, which was *Toothed* or *Pectinated* about the Edges, tyed firmly down to the bottom of the Mouth, all along the Middle, as *Aristotle* truly saith.

Whence I cannot but wonder that *Rondeletius* should herein contradict *Aristotle*, and affirm, (contrary to Truth, as I believe) *quod Delphinis Lingua est mobilis, quae modo exerimodo condi potest*; unless perchance in this Particular the *Dolphin* differs from the *Porpus*. For the *Porpus* is, as I take it, the *Phocaena* of the *Ancients*, which is a lesser sort of *Dolphin*, and not the *Dolphinus*: at least if the Fish we are describing were a *Porpus*; for the Teeth of this Fish were lesser than, and of a different Figure from those in the Jaw of the *Dolphin* we got beyond Seas, yet is the Difference not great between the *Dolphin* and *Phocaena*. As for that Fish, which our *Seamen* now a days call the

the Dolphin, and which, as it is described by Mr. Terry and Ligon hath Taste on its Tongue, small Scales, is Finn'd like a Rock, of a pleasant Smell and Taste, what it is I know not, but I am sure it is *totò Genere* different from the Dolphin of the Ancients.

We observed not in this Fish any Nostrils, besides those in the *Fistula*, nor any Ear holes or *Meatus Auditorii* at all: wherein also Aristotle agreeth with us, which yet Rondeletius found out near the Eyes. But we observed in the Skull a Bone, answering to the *Os Petrosum*, which most certainly was the Use of Hearing.

As for the same Porpus, I agree with Gesner, that it was so called, *Quasi Porcus Piscis*, most Nations calling this Fish *Porcus marinus*, or the Sea-swine. Indeed it resembles a Swine in many Particulars, as the Fat, the Strength of the Snout, &c.

A venomous
scratch with
the Tooth
of a Porpus,
by Dr. M.
Lifter n.
233. p. 716.

LXXVII. Forte ex Dissectione Delphini, ante Dies tres minimum mortui, admodum leviter Digitum vulneravi ab interna Parte; at citra Sanguinem scilicet simplici Dentis Rasura. Nihil autem Mali inde sensi ad Quartum usque Diem; quo tempore cum quodam Livore Digitus paululum intumuit ad Articulum. Malum indies serpebat, adeo ut, intra alios quatuor, Digitos duos infecisset; tertiusque tandem Digitus male se habuit. Plurima ex Concilio Chirurgorum adhibui, at parum profuerunt, jam Manus correpta est, Dolorque Carpum invasit, ex hoc autem Fomento primum stetit. (R. *Aque Spermatidis Ranarum* 3vi. *Boli Armen.* 3ss. f. *Vitrioli Albi* 3 iiii. m.) Calide bis quotidie admotum est. Item interdum alio modo (R. *Vitrioli Albi Combusti, Boli Armeniae. an.* 3 iiii *Camph.* 3 i. *Aq. communis* lb viii. m. f. *Callyrium.*) Deinde Nutrito imposito & superinjecto Emplastro ex Dolo & Diapalma, convaleui ex hoc inusitato ac improvise Malo. Præter Livorem autem, qui satis Venenum indicabat, Molestus ac Odiosus quidam Pruritus, an Igniculus dicam, me Dies, Noctesque vehementer angebat, *Cuticulam* Partium correptarum ex toto perdidit; Digni autem ad Vires suas non nisi post aliquot Menses restituti sunt.

Poisonous
Fish about
the Bahama
Islands by
M. J. L. n.
114. p. 313.

LXXVIII. The Fish that are here, (at New-Providence one of the Bahama Islands) are many of them poisonous, bringing a great Pain on their Joynts, who eat them, which continues so for some short time, and at last with two or three Days Itching the Pain is rubb'd off. Those of the same Species, Size, Shape, Colour and Taste, are one of them Poison, the other not in the least hurtful, and those that are are so only to some of the Company; the Distemper to Men never, that we hear of, proves mortal: Dogs and Cats sometimes eat their last. In Men that have once had that Disease, upon the first eating of Fish, though it be those that are wholesome, the Poisonous Ferment in their Body is revived thereby, and their Pain increased.

Whales and
Whale Fi-
shing about
Bermudas,
by ... n. 1.
p. 115.

LXXIX. I. An understanding and hardy Seaman gives this Account of the Whale Fishing about the Bermudas; that tho' many Attempts of Mastering the

the *Whales* of those Seas had been unsuccessful, by reason of the extraordinary *Fierceness* and *Swiftness* of these monstrous *Animals*, yet the *Enterprize* was lately renewed, and six Persons having been out at Sea 17 times, and fastened their Weapons a Dozen of times, they kill'd in these *Expeditions*, 2 old *Female Whales*, and 3 *Cubs*, whereof one of the old ones, from the Head to the Extremity of the Tail, was 88 Foot in length, by Measure, its Tail being 23 Foot broad, the *swimming Fin* 26 Foot long, and the *Gills* 3 Foot long, having great Bends underneath from the *Nose* to the *Navel*, upon her after Part, a Fin on the Back, being within paved (this was the plain Seaman's Phrase) with Fat like the *Cawl* of a *Hog*. The other old one, he said, was some 60 foot long: Of the *Cubs*, one was 33, the other two much about 25 or 26 Foot long. The Shape of the Fish, he said, was very sharp behind, like the Ridge of a House; the Head pretty bluff, and full of Bumps on both sides, the Back perfectly black, and the Belly white.

Their *Celerity* and *Force* he affirmed to be wonderful, insomuch that one of these Creatures which he struck himself, towed the Boat wherein he was, after him, for the space of 6 or 7 Leagues in $\frac{1}{4}$ of an Hour's time. Being wounded, he saith they make a hideous roaring, at which all of that kind that are within Hearing, come towards that Place where the Animal is, yet without striking or doing any Harm to the wary. He is of Opinion, that this Fish comes nearest to that sort of *Whales* which they call the *Jubartes*, they are without *Teeth*, and longer than the *Greenland Whales*, but not so thick. That they feed much upon Grass growing at the bottom of the Sea, was seen by cutting up the great Bag or Maw, wherein he had found in one of them about 2 or 3 *Hogsheads* of a greenish grassy Matter.

The largest sort of these *Whales* might afford 7 or 8 *Tuns* of *Oyl* if well husbanded; the *Cubs* yield but little, and that is but a kind of Jelly. That which the old ones render, doth candy like *Pork's Grease*, yet burneth very well. He observed that the *Oyl* of the *Blubber* is as clear and fair as any *Whey*; but that which is boil'd out of the *Lean* interlarded, becomes as hard as *Tallow*, spattering in the Burning; and that which is made of the *Cawl* resembleth *Hog's Grease*. He affirms that though this *Grease* be boiling, yet one may run ones Hand into it without scalding; to which he adds, that it hath a very healing Vertue for *Cuttings*, *Lameness*, &c. the Part affected being anointed therewith.

The time of *Catching* these *Fishes* is from the Beginning of *March* to the End of *May*, after which time they appear no more in that Part of the Sea, but retire, as it is thought, into the *Weed-beds* of the Gulf of *Florida*, it having been observed, that upon their *Fins* and *Tails* they have Store of *Clams* or *Barnacles*, upon which he said, *Rock-weed* or *Sea-Tangle* did grow a Hand long; many of them have been taken off them, of the Bigness of great *Oyster Shells*.

The same Person saith, that since his former account there hath been taken by order of the *Bermudas Company*, 16 of those *Whales*, the *Oyl* whereof, to the Quantity of 50 or 60 *Tuns*, arrived in *Ireland* some few Months ago.

He adds, that about 2 Years since, there stranded upon the Coast of *New-England*, a dead *Whale* of that sort which they call *Trumpe*, having *Teeth* resembling those of a *Mill*, and its *Mouth* at a good distance from, and under the *Nose* or *Trunk*, and several Boxes or Partitions in the *Nose*, like those of the *Tails* in *Lobsters*, and that being opened, there run out of it a thin Oiley Substance, which would candy in time, after which the Remainder being a thick fatty Substance, was taken out of the same Part with a Scoop. And this Substance he affirmed to be the *Sperma Ceti*; adding further, that the *Blubber*, as they call it, it self, of the same sort of *Whales*, when stewed, yields on the top a Creamy Substance, which taken off, and thrown upon *White-wine*, lets fall a dirty Heterogeneous Sediment, but what remains aloft, affords a *Sperma-Ceti-like* Matter.

He concludes his Relation with observing, that these *Whales* were to be met with between the Coast of *New-England* and *New-Netherland*, where they might be caught 8 or 9 Months in the Year; whereas those about the *Bermudas* are to be found there only in the Months of *February*, *March*, and *April*.

Concerning the *Death* of the *Whale*, which hath been related to have stranded upon *New-England*, it is not very improbable but that it may have been kill'd by a certain *Horny Fish*, which is said by *Mr. Terrey*, in his *East-India Voyage*, to run his Horn into the *Whale's* Belly; and which is known sometimes to run his Horn into Ships, perhaps taking them for *Whales*, and there snapping it asunder, as happened not long since to an *English* Vessel in the *West-Indian* Seas.

2. Within these 2 or 3 Years in the Spring time, and fair Weather, they take sometimes one, two or three *Whales* in a Day. They are less, I hear, than those in *Greenland*, but more quick and lively; so that if they be struck in deep Water, they presently make into the Deep with such Violence that the Boat is in Danger to be haled down after them, if they cut not the Rope in time; therefore they usually strike them in Shoal Water. They have here very good Boats for that Purpose, Mann'd with six Oars; such as they can row forwards or backwards, as Occasion requireth. They row up gently to the *Whale*, and so he will scarcely shun them; and when the *Harpineer*, standing ready fitted sees his Opportunity, he strikes his *Harping Iron* into the *Whale* about or before the Fins, rather than toward the Tail. Now the *Harping Irons* are like those which are usual in *England* in striking *Porpus's*; but of singular good Metal, that will not break, but wind, as they say, about a Man's Hand. To the *Harping Iron* is made fast a strong Lythe Rope, and into the Socket of that *Iron* is put a Staff, which when the *Whale* is struck comes out of the Socket, and so when the *Whale* is something quiet, they hale him up by the Rope, and it may be, strike into him another *Harping Iron*, or lance him with Lances in Staves till they have kill'd him. I do not hear that they have found any *Sperma Ceti* in any of these *Whales*; but I have heard from credible Persons, that there is a kind of such as have the *Sperma* at *Elutheria*, and others of the *Bahama*

Bama Islands (where also they find often Quantities of *Amber Greece*;) and that those have great *Teeth* (which ours have not,) and are very *Sinewy*. One of this Island of *Bermudas* (*John Perinchief*) found one there dead, driven upon an Island; and though I think ignorant in the Business, yet got a great Quantity of *Sperma Ceti* out of it. It seems they have not so much Oil as ours; but the Oil, I hear, is at first, like *Sperma Ceti*, but they *clarifie* it, I think, by Fire.

4. We have in these Seas about *Bermudas* great store of Whales, which in *March, April* and *May*, use our Coast. I have my self killed many of them. Their Females have abundance of Milk, which their young ones suck out of the Teats, that grow by their Navel. They have no Teeth, but feed on Moss, growing on the Rocks at the bottom, during these 3 Months, and at no other Season of the Year. When that is consumed and gone, the Whales go away also. These we kill for their Oil: But there have been *Sperma-Ceti-Whales*, driven on the Shore, which *Sperma* (as they call it) lies all over the bodies of those Whales. These have diverse Teeth, which may be about as big as a Man's Wrist.

I have been at the *Bahama-Islands*, and there have been found of the same sort of Whales dead on the Shore, with a *Sperma* all over their bodies, but I could never hear of any of that sort that were killed by any Man; such is their Fierceness and Swiftnes. One such Whale would be worth many Hundred Pounds. They are strong, and inlaid with Sinews all over their body, which may be drawn out thirty fathom long.

LXXX. F. I conjecture that Fishes, by Reason of the Bladder of Air that is within them, can sustain or keep themselves in any Depth of Water; for the Air in that Bladder being more or less compressed, according to the Depth the Fish swims at, takes up more or less space; and consequently the Body of the Fish, part of whose Bulk the Bladder is, is greater or less according to the several Depths, and yet retains the same Weight. Now the Rule *de Insidentibus Humido*, is, that a Body that is heavier than so much Water, as is equal in Quantity to the Bulk of it, will sink; a Body that is lighter will swim; a Body of equal Weight will rest in any Part of the Water. By this Rule if the Fish in the middle Region of the Water, be of equal Weight to the Water that is commensurate to the Bulk of it, the Fish will rest there without any Tendency upwards or downwards: And if the Fish be deeper in the Water, the Bulk of the Fish becoming less by the Compression of the Bladder, and yet retaining the same Weight, it will sink, and rest at the bottom: And on the other side, if the Fish be higher than the middle Region, the Air dilating it self, and the bulk of the Fish consequently increasing, but not the Weight, the Fish will rise upwards, and rest at the Top of the Water.

Perhaps the Fish by some Action can emit Air out of his Bladder, and afterwards out of its Body, and also, when there is not enough, *Take in Air* and convey it to this bladder; and then it will not be wondred, that there should

By Mr. Rul.
Stofford, D.
40, p. 79.

The Use of
Air Bladders
in Fishes;
By
114, p. 120.

should be always a fit Proportion of Air in the Bodies of all Fishes, to serve their use according to the Depth of Water they are bred and live in: Perhaps by some Muscle the Fish can contract this Bladder beyond the Pressure of the Weight of Water. Perhaps the Fish can by its sides, or some other Defence, keep off the Pressure of the Water, and give the Air leave to dilate itself. In these Cases the Fish will be helped in all intermediate Distances, and may rise or sink from any Region of the Water without moving one Fin.

By Mr. Boyle
ib. p. 311.

2. To determine whether a Fish doth rise or sink in Water by *Constricting* or *Expanding* himself; take a Bolt-head with a wide Neck, and having filled it almost full with Water, put into it some live Fish of a convenient size; that is, the biggest that can be got in, as a *Roche*, *Perch*, or the like, and then draw out the Neck of the Bolt-head as slender as you can, and fill that also with Water. Then observe the Motion of the Fish, and if upon his *sinking* you perceive the Water at the slender Top does subside, you may infer, he *Contracts* himself, and if upon his *rising*, the Water be also raised, you may conclude, he *Dilates* himself.

By Mr. Ray.
ib. p. 349

3. I think that _____ hath hit upon the true use of the *Swimming-Bladder* of Fishes. For 1. It hath been observed, that if the *Swimming-Bladder* of a Fish be *Pricked* or *Broken*, such a Fish *sinks* presently to the bottom, and can neither support nor raise up it self in the Water. 2. Flat-fishes, as *Soles*, *Plaice*, &c. which lie always groveling at the bottom, have no *swimming Bladders* that I could ever find. 3. In most Fishes there is a manifest *Channel* leading from the *Gullet*, or upper Orifice of the Stomach, to the said Bladder, which without doubt serves for conveying Air thereunto: But there is a *Valve* or some other Contrivance to hinder the Egress of it, so that you shall sooner break the Bladder than force any Air out by this Channel. Yet in *Sturgeons*, Mr. *Willoughby* hath observed, that pressing the Bladder, the Stomach presently swelled: So that it seems in that Fish the Air passes freely both ways.

I verily think there is in the Coat of this Bladder a Musculous Power to contract it when the Fish lifts: For, in many Fishes it is very thick and Opake, like the Coat of an Artery (which hath, as Dr. *Willis* observes, such a Muscular Faculty) as for Example, in all the Cod kind; in some, v. g. the *Hake*, call'd in Latin *Morone*, it is inwardly covered with a Red Carnous Substance, which I take to be Musculous Flesh; in others it is forked at the Top, and to each Horn hath a Muscle affixed. Now the Musculous Force need not be great, being still assisted by the Water, as the Fish descends; the Pressure of the Water being much greater at the bottom, than at the Top.

The Power also of *dilating* the *Abdomen* by the Muscles assists those Fishes to rise, whose Natural Place is towards the bottom: And the Air compressed in the Bladder dilating it self as the Fish ascends, facilitates that Action of the Muscles. But those Fishes that descend by *contracting* the Bladder, letting the *contracting Muscle* cease to act, will rise again of their own Accord, the Air within dilating it self; as we see in Glass Bubbles by *Compression* of the Air in them descending, which, as soon as the Force is removed, ascend without more ado.

Besides

Besides the Flat Fishes I before mentioned, all the *Cartilaginous* Kind, as well Flat as Long, want *Swimming Bladders*: What Course they use to *Ascend* and *Descend* in the *Water*, I know not. Many of the *Eel-kind* (not all) have *Swimming Bladders*, yet can they hardly raise themselves in the *Water*, by reason of the length and Weight of their *Tails*: I suppose, the *Air Bladder* being near their Heads helps them to lift up their Head and Forepart.

LXXXI. I have observed in the Eyes of Fish that the *Processus Ciliaris* is not fasten'd to the joyning of the *Cornea* and *Sclerotis* as in all other Animals that I dissected, so as to hinder the *Watery Humor* to go any further backward. For I constantly observe that the *Humor Aqueus* may move a good way backward in some, and in others almost as far as the *Optick Nerve*. And in as many Fish as I could conveniently examine carefully, I have found a *Membrane* which covered the *Tunica Cornea*, so as not to let any *Water* come to it. This answers the *Membrana Nictitans* in *Fowl*; and reaches on all sides to the *Cutis* of the Fish to which it is fastened. This is Transparent, and pretty Thin; and so is all the *Cornea*, if compared to that of *Quadrupeds*.

The Eyes of Fish; By Dr. Allen Moulton n. 199. p. 716.

I have also observed that the Eyes of Fish, as well those of *Fowl*, are more or less *Cartilaginous*: For the *Sclerotis* is a *Cartilago sui Generis*, especially near the *Cornea*; and in the larger sorts of them, I have found the whole *Sclerotis* such a kind of a *Cartilage*.

LXXXII. Fish are remarkably different from all other Animals in many particulars. The most considerable difference is their want of *Lungs*, and their not *Breathing*: And yet it is Necessary that something should supply this in Fishes, which may have the same Effect upon their Blood, as the *Air* has upon ours, by entering into our *Lungs*, that is to say, to *Divide* and *Dissolve* it, and render it fit for *Circulation*. Now we find no part in Fish more proper to produce this Effect than the *Bronchie*, that lie like so many Leaves upon each other under their *Gills*: For they receive the *Water* in by the Mouth, and return it by the *Gills*, or Receiving it in by the *Gills* they Throw it out by the Mouth. Hence it is agreed upon by all that the *Water* contains something that Produces this Effect, and this seems most probably to be *Air*.

The Structure of the Internal Parts of Fish: by Dr. Char. Preston. n. 225. p. 419.

That there is *Air* in all *Water* cannot be doubted after this Experiment of M. Marolle. He set a Vessel of *Water* over the *Fire*, so to drive out the *Air* from it. This *Water* he put into the *Air Pump* to draw out the *Air* from it; and after that fill'd a Vial with it, within 2 or 3 Fingers of the Top, which space he left only full of *Air*, and stop't the Vial well; and by shaking it the *Water* imbibed the *Air*, so as to rise up and quite fill the Vial.

But we need not wonder that Fish cannot also Live in the open *Air*: Their Blood is Naturally less Hot than ours, so that the natural Heat of ours would be a Fever in them, and Mortal: For the *Nitre* of the Pure *Air* is in too great

great a *Quantity*, and too subtile, so that it Dissolves their Blood too much, and makes it too *Fluid*, whereas the *Nitre* in the *Water* is more Gross and in lesser Proportion; whence it gives their Blood only a *Fluidity* requisite to keep it in its *Natural State*. To prove that it is in the *Bronchiæ* that this Division is performed, we need but Observe their Extraordinary Redness above any other part of the Body; a Proof that the Blood is there more Divided. Fish are also found to die in *Water* frozen over, which happens plainly from their Communication with the *outward Air* being hindered by the *Ice*.

The *Heart* of Fish is Different from that of other *Animals* in its having but one *Ventricle*: For it has only the *Vena Cava* and the *Aorta* that open into it, having no *Lungs*. So that by the *Aorta* the Blood comes out of the *Heart*, which is Branched into a Thousand *Capillaries* over the *Bronchiæ*, and is after Reunited; which Re-union is made under the *Basis* of the *Cranium*; and because the Blood, when once there, has no need of being forced higher upwards, they have no occasion for a second *Ventricle* for that purpose, as *Terrestrial Animals* have. The Reunion of these *Capillaries* of the *Bronchiæ* being made, they form two large *Trunks*, of which one proceeds towards the *Head*, and the other towards the lower Parts.

Fish have a *Diaphragm*; but not for the same Purpose as in other *Animals* that Breathe. It is always strait and tense, and Perpendicular on the *Vertebrae*; it hinders the *Terminating Salts* that Exhale from the *Intestines* from coming to the *Heart*, which might cause some Alteration there.

Their *Stomach* is *Membranous*; for Fish swallow down other smaller Fish whole, and sometimes Earth. Wherefore 'tis needful to have a Power of Contracting and Straitning it self, forceably to break to pieces the hard Matters contained therein. Their *Intestines* make several great Windings about; a Sign the *Fermentation* is but slow therein; which is made up by the length of the *Intestines*. The *Liver* has much the same Situation as in other *Animals*; as also the *Spleen* has. They are provided of a *Gall-Bladder*, a *Ductus Choledochus* and *Pancreas*, or rather two little Bags fastened to the *Ventricle* for the same use. Fish have usually many *Pancreas's*, so that in some there have been told 44. They have *Kidneys*, *Bladder*, &c.

They have the *Ovary* near the *Vertebrae* of the *Loins*. The *Eggs* come forth at a Passage below the *Anus*: And the *Male* has a like *Ductus*, or *Hole*, by which they eject their Seed upon that of the *Female* to impregnate the *Eggs*: which the *Male* sometimes Changes the Colour of, as he passes over them, when he casts his Seed upon them after they are Laid.

Fish have on the *Vertebrae* of the *Loins* a *Bladder*, very large in Proportion to their Bulk; which serves, by *Compressing* or *Dilating* it self, to render the Fish more or less heavy, as Occasion requires. The *Fins* and *Tail* assist them in their Passage through the *Water* whither they will: But 'tis this *Dilatation* that makes them capable of swimming in it; and if this *Bladder* be by any

any means Burst, so that it cannot be Extended, the Fish can no more raise it self in the Water, but keeps continually at the Bottom. Flat fish, such as Soles, have none of this Bladder: For they are able, by Reason of their Breadth, to keep themselves up in the Water. Cray-fish, and other Shell-fish want it likewise, for the most part; for they creep only at the bottom of the Water. There are many Fish that have them Double.

LXXXIII. *Anserum Ferorum* Quinque Genera vulgo numerantur in *Agro* Wild-Goose, by Dr. M. Lister, p. 175; p. 1160.
Eboracensi satis frequentium; viz. 1. The little Spanish Goose; Sc. *aque* Goose, by Dr. M. Lister, p. 175; p. 1160.
Parvus ac Brenta; sed Figura & Colore quodammodo ad *Anserem Domestico* accedens; ab *Hispania* denominatur. 2. The Barnacle satis cognitus.
 3. The Scotch Goose; Sc. *Vulgarissimus Ferus*, a *Scotia* ad nos, exeunte *Augusto* adveniens, e quibus fere constant innumeri illi Greges qui in Planis Campis (the *Woods* dictis) & alibi passim inveniuntur. 4. The *Whilk*, *Anser Maximus Niger*, ineunte *Bruma* primum adveniens; raro alibi quam in Pratis, Pascuisque Herba pascitur. 5. *Anser Palustris* Noster, *Grey Lagg* dictus; huic Magnitudo *Anseri Domestico* subpar.

Caput ex *Fusco Nigricat*, & ad Medium Collum *Infuscatur*; Dorsum ex *Cinereo Livescit*, ipsæ autem Alæ, & earum Remiges *Nigricant*. Uropygium *Albescit*, ejusque Pennæ Externæ *Albidæ* sunt; Venter *Cinereus*, is vero Imus sensim fit *Nivens*; Rostrum a Capite ad Mediam fere partem *Nigrum*, deinde *Subpurpureum*, ipso ejus Apice *Nigro*; in Superiore Mandibula non nisi unus *Denticulorum* Ordo, atque idem Simplex Ordo in inferiore: item huic Lingua utrinque Uno *Denticulorum* ordine armatur. Pedes *Subpurpurei*, sive *Carnei Coloris*; Ungues fere *Albidi*, excepto medii Digiti, qui ex majore parte *Nigricat*. Pendet *Libris 7.* & fere *Dimidium*. In Paludibus *Agri Eboracensis* Nidificant; ipsi & eorum Pulli Mense *Mai* pinguescunt, & in Deliciis habentur.

But I will not affirm the *Grey Lagg* to be different from the Common ib. p. 1161
Wild Goose; Mr. Ray's Description and mine so well agree, save in the Colour of the Bill and Legs.

LXXXIV. In the Western Islands of Scotland, the West Ocean throws upon their Shores great Quantities of very large Weather-beaten Timber; the most Ordinary Trees are *Fir* and *Ash*. Being in the Island of *East*, I saw The Barnacle, by Sir Rob. Murray, 137, p. 925.
 lying upon the Shore a cut of a large *Fir-Tree* of about $2\frac{1}{2}$ foot Diameter, and 9 or 10 foot long, which had lain so long out of the Water, that it was very dry, and most of the Shells that had formerly covered it, were Worn or Rubbed off. Only on the Parts that lay next the Ground, there still hung Multitudes of little Shells: They were of the Colour and Consistence of *Muscle Shells*. This *Barnacle-Shell* is thin about the Edges, and about half as thick as broad. Every one of the Shells hath some Cross Seams, or *Sutures*, which as I remember divide it into 5 parts, near about the manner as in the Figure. Fig. 238.

These Parts are fastened one to another, with such a Film as *Muscle Shells* are.

These Shells hung at the Tree by a Neck longer than the Shell, of a kind of a *Filmy* Substance, round and hollow, and creased, not unlike the *Wind-Pipe* of a *Chicken*, spreading out broadest where it is fastened to the Tree; from which it seems to draw and convey the matter which serves for the Growth and *Vegetation* of the Shell and the little Bird within it.

In every Shell that I opened I found a Perfect *Sea-Fowl*; the little Bill like that of a *Goose*; the Eyes marked; the Head, Neck, Breast, Wings, Tail, and Feet, formed; the *Feathers* every where perfectly Shaped, and Blackish coloured; and the *Feet* like those of other *Water-Fowl*, to my best Remembrance. The biggest I found upon the Tree, was but about the Size of the *Figure*; nor did I ever see any of the little Birds alive, nor met with any Body that did; only some Credible Persons have assured me that they have seen some as big as their *Fist*.

The Scotch
Barnacle and
French Ma-
creuse; By
Dr. Tancred
Robinson, n.
272. p. 1036.

LXXXV. 1. The Bird which at *Paris* is called *Macreuse*, and in other parts of *France*, *Macroul*, the French Eat upon *Fish Days*, and all *Lent*, thinking it to be a sort of *Fish*, or a *Marine Animal* with *Cold Blood*, or else a *Barnacle* Generated either out of *Rotten* or *Corrupted Wood* floating upon the *Sea*; or out of certain *Fruits* falling into the *Water*, and there Metamorphosed into a *Bird*; or else from a kind of *Sea-Shells*, adhering to Old Planks and Ship Bottoms, called *Conchæ Anatiferae*. But in truth these *Shells* contain a *Testaceous Animal* of their own Species, as the *Oyster*, *Cockle*, and *Muscle* do: Whereas the *Barnacle* is of the *Goose*, and the *Macreuse* of the *Duck* kind, and both *Oviparous*; the Truth of which is Evident by the Anatomy of their Parts serving for *Generation*, and by their *Laying Eggs* and sometimes *brooding* among us.

The *Macreuse* is the *Scoter*, or *Anas Niger Minor* described by Mr. Ray. It is frequently taken in Nets placed under water upon the Coasts of *Normandy* (most plentifully at the Mouth of the *Sein*) *Languedock* and *Provence*; and I am confident, I have seen it upon the *Laguna* of *Venice*, at the Mouths of the *Brenta*, *Addessu*, and the *Po*. A *Duck* very like unto this (if not the same,) I also saw upon the *Mare Mortuum*, and the *Lake Avernus*.

The Macre-
use; By Mr.
Ray. lib. p.
304 l.

2. I had no sooner seen the *Cases* of the *Male* and *Female Macreuse*, which Dr. Robinson sent me, but instantly I found it was no Stranger to me. There is a particular Description of the *Cock* in Mr. Willoughby's *Orniology* among the *Sea Ducks*, to which this Bird belongs, and not to the *Divers* or *Duckers*. M. Graindorge's Description I find upon attent reading to be very Faithful: But notwithstanding what he saith of the *Debility* of its *Feet*, unfit for *Walking* on *Land*, I see not but that it may *March* as well as the rest of its kind, all which have but *Short* and *Weak Legs* in Proportion to the bulk of their *Bodies*, and those also situated very backwards.

What he saith of the Smallness and Weakness of the Wings, and Shortness of their *Feathers*, is common to many Sea-fowl, viz. the *Tridactyle* and *Mergi* which yet by the Nimble Agitation of them, fly very swiftly and strongly.

Why they of the Church of Rome should allow this Bird to be Eaten in Lent, and upon other Fasting Days, more than others of this Kind, but especially the *Tridactyle*, I see no Reason; the *Flesh* of these last, which Live only or chiefly by Preying upon Fish properly so called, tasting stronger of Fish than the Duck kind, which all feed, partly at least, upon Shell-fish (as M. Graindorge found the *Macreuse* also to do) and have a delicate and well tasted *Flesh*.

I observe in this Bird, and in some others of the Sea-Ducks that are much under water, that they Want that *Vessel*, or *Ampulla*, situated in the very Angle of the *Divarication* of the wind Pipe, which for want of a better and fitter Name we are wont to call the *Labyrinth* of the *Trachea*. We may very probably from hence Conclude, that the *Labyrinth* doth not serve them for a *Reservatory* of Air, to enable them to continue the longer under water, as I sometimes conjectured, but for the intending and Modulating of the Voice, seeing in the *Plash Duck* the Females want it: But I am somewhat to seek about the Use of this *Vessel*. I Observed it in the *Mergus Cirratus longiroster major* or the *Dun-Diver*, and that very large, and extended by very strong Bones, and yet I thought my self to have sufficient reason to Judge that Bird to be the Female of the *Merganser*: But I dare not be confident that it is the Female because of this *Labyrinth*.

LXXXVI. In the Houses built for this Use there is a long Entrance, *a b*. The Manner of Marching Chickens at Cairo, By Mr. Jo. Graves, n. 117. p. 93. Fig. 237.

on each side of which are 14 Ovens (some places have more, some less.) The bottoms and sides of these Ovens which are on the Ground, are all made of Sun-dried Bricks, upon which they put Mats, and on the Mats, Eggs. The top of these Ovens are flat, and covered with Stricks, except 2 long spaces which are made of Sun-dried Bricks; and are the Hearths, in which the Fires are made, to Heat the Eggs lying under them in the lower Ovens.

Above these lower Ovens are so many other, made of Sun-dried Bricks, and Arched at the top: Where also there are some Holes, which are stop'd with Tow, &c. or left open, as they please, to govern the Heat in the Ovens below. These upper Ovens are made after this manner,

a. The Mouth of the Oven, opening upon the long Entrance above mention'd. b. and c. Entrances into the Ovens adjoining. d. e. two Hearths 3 or 4 inches deep, in which they make the Fire, to Heat this and the Oven below. The depth of the lower Oven is about 2½ foot English: the Second above 4.

They begin in the midst of January to Heat the Ovens: Spending every Morning an 100 Kintars (or an 100 Pound Weight) of Camels, or of Buffalo's Dung, and the like Proportion at Night, till the midst of February, about

Q q q q q 2

which

which time the Ovens are so hot, that one cannot well endure to lay his Hand upon the Walls.

After this, they put the Eggs into the Ovens to hatch the Chickens; which they continue successively till the end of May.

The Eggs are first put upon Mats in the lower Ovens, which are upon the Ground, 7 or 8000 Eggs in Number; and laid only double one upon another.

In the Ovens above these lower, the Fire is made in the long or little Channels, from whence the Heat is conveyed into the lower Ovens before mentioned. The Eggs which are directly under these Hearths, lie treble one upon another; the rest, as was said, only double.

At Night, when they new make their Fires in the Hearths above mentioned, they then remove the Eggs that were directly undermost (lying three one upon another) in the place of those which lay on the sides only double; and these being now removed, they lie treble under the Hearth, because the Heat is greater there, than on the sides.

These Eggs continue in the lower Ovens 14 Days and Nights: Afterwards they remove them into the upper Ovens; which are just over the lower. In these (there being now no more Fire used) they turn all the Eggs four times every 24 Hours.

The 21. or 22 Day the Chickens are hatched; which the first Day eat not; the second, they are fetched away by Women, who give them Corn, &c.

The Master of the Ovens hath a 3d Part of the Eggs for his Cost and Pains; out of which, he is to make such good unto the Owners (who have two Thirds in Chicken for their Eggs) if any happen to be spoiled or miscarry.

The Fire in the upper Ovens, when the Eggs are placed in the lower, is thus proportioned.

The first Day the greatest Fire, the second less than the first, the fourth more than the third, the fifth less, the sixth more than the fifth, the seventh less, the eighth more, the ninth without Fire, the tenth a little Fire in the Morning, the eleventh they shut all the Holes with Flax, &c. making no more Fire; for if they should the Eggs would break.

They take Care, that the Eggs be no hotter than the Eye of a Man, when they are laid upon it, can well endure.

When the Chickens are hatched, they put them into the lower Ovens, which are covered with Mats. Under the Mats is Bran to dry the Chickens: and upon the Mats Straw, for the Chickens to stand upon.

To breed up
Pheasants
and Partrid-
ges; by Sir
Edm. King.
A. 21. p. 428.

LXXXVII. *Ants* are the principal Food of very young *Partridges* and *Pheasants*, both wild and tamed, for several *Weeks*: And a chief Reason, why many find it so nice a thing to breed up the said *Birds* is, that either they give them too sparingly of this Food, or let them fast too long; not knowing, that as soon as 'tis Day light, they will seek it for their Breakfast, and if they want

want it, will in a few Hours be faint and weak, and some grow so Chill for Want of that Supply of Nourishment, that it is no easy Matter to recover them. But afterwards, when they are grown bigger, if by ill ordering of those who should keep them sweet and often shift their Water, or by ill Dyet or musty Corn, &c. they become sick, then *Ants* will not always recover them, tho' you give them never so many; and I have been forced to make use of other Insects to cure them, as *Millepedes* and *Earwigs*; either of which will do good, but both together better, given in a good Quantity, and at least two or three times a Day. But then those other things must be observed too, of keeping their House clean, and giving them sweet Corn and shifting their Water twice a Day, keeping them within till the Dew be from the Ground, letting them bask in the Sand, partly in the Sun, the Place being a little shaded, and putting them up in a warm House before Sunset.

LXXXVIII. 1. It is most certain that *Swallows* sink themselves towards Autumn into *Lakes*, no otherwise than *Frogs*; and many have assured me of it, who have seen them drawn up with a *Net*, together with *Fishes*, and put to the Fire, and thereby revived. Small water found in L. Key in Winter by M. J. Schefferus, 1719, p. 350.

2. I have frequently heard *Fishermen* affirm, that they have here, about *Dantzick*, often fished them out of the *Lakes* in the *Winter*, but I never have seen it my self. By M. J. Hevelius, ib. p. 347.

LXXXIX. The *Ortygometra*, or *Rail*, is a sort of Fowl very numerous in all Parts of *Ireland* in its Season; but that's but short, and lasts not above 3 or 4 Months in the *Summer*; during all the remaining Parts of the Year, it lies buried and asleep under Ground. The Rail, by Dr. Thomas Molineux, 1734. p. 747.

XC. That sort of Bird mentioned by Dr. Plot to be often heard in *Woodstock Park*, (from the Noise it makes commonly call'd the *Wood crack-er*,) is perhaps the lesser sort of *Picus Martius Varius*: For since the Publishing of Mr. *Willoughby's Ornithology*, I have observed that Bird sitting on the top of an *Oaken Tree*, making with her Bill such a Cracking or Snapping Noise, as we heard a long way off; the several Snaps or Cracks succeeding one another with that Extraordinary Swiftnes, that we could not but wonder at it. But how she made the Noise, whether by the nimble Agitation of her Bill to and fro in a Rift of the Bough, or by the swift Striking of the Mandibles one against another, as the *Stork* doth, I could not clearly discern: But an intelligent Gentleman, who was very diligent in observing the same Bird, said it was the former Way. The Wood-cracker, by M. Ray, 1772. p. 1041.

XCI. *Aviculam*, quam a *Germanis Silk Tail* vulgo appellari audio, unam aut alteram *Sclopeti glande transfixam*, *Eboraci*, exeunte *Januario* 1680. vidi. Sane perquam elegans *Avicula* est; Magnitudine *Turdum* fere aequabat; huic in extremis alarum Pennis 4 aut 5 Apices Parvi *Coccinei Nudi*, *Cornei*, minime: The Silk Tail, by Dr. M. Lister, 1755. p. 1161.

minime Plumis Vestiti; item in extrema Cauda Limbus, Latus, Luteus, instar Corticis Citri, cætera maximam partem Lanium Colore refert.

But I have since view'd the *Bill* of this kind of *Bird* at Mr. *Charlton's*, and find it to want the Notches in the upper Part of the *Bill* proper to the *Lanius Kind*, it must therefore be put among the *Jaws*.

The humming Bird,
by Mr. Jo.
Winnick, n.
74. p. 222.

XCII. 1. I have sent you the curiously contrived *Nest* of a *Humming Bird* so called from the *humming Noise* it maketh whilst it flies. 'Tis an exceeding little Bird, and only seen in Summer, and mostly in Gardens, flying from Flower to Flower, sucking *Honey* out of the Flowers as a *Bee* doth; as it flieth, not lighting on the Flower, but hovering over it, sucking with its long *Bill* a sweet Substance. There are in the *Nest* 2 of that Birds Eggs, whether they use to have more at once I know not.

By Mr. O.
denburg, ib.

2. These Eggs were so small, that being weigh'd by me, the one weighed but about 5 Grains, the other $3\frac{1}{2}$: And the whole *Nest* weighed no more than 24 Grains.

By Mr. Hamersley, n. 200.
p. 760. n.
201. p. 815.

3. There is in most parts of *America* a Bird call'd by the *English* the *Humming Bird*, by the *Spaniards* *Tomincins*. He is of a most excellent shining green Colour, and very resplendent; the Colour doth something resemble some of our *English Drake's Heads*. It doth inhabit in some of the colder Parts of *America*, as well as in the hotter. It is the least of all Birds that I have seen there or in *England*, her Leg and Foot together is but half an *Inch*, the other Parts answerable; the Trunk of her Body not an *Inch*. I did weigh one in those Parts as soon as ever it was killed, whose Weight was the 10th part of an Ounce *Avoirdupois*, which I take to be about the Weight of a coined *Sixpence*: And I have weighed here in *England* a *Tit Mouse*, (which I take to be the least Bird here) and it weighed above two *Shillings*, and some half a *Crown*. I saw one of their *Nests* made of *Cotton Wool*, in form and bigness of the *Thumb* of a Man's *Glove*, with the taper End set downwards, wherein were 2 Eggs of the bigness of a *Pea*, of Oval form. They feed by thrusting their *Bill* and *Tongue* into the *Blossoms* of *Trees*, and so suck the sweet Juice of *Honey* from them; and when he sucks he sits not, but bears up his Body with a hovering Motion of his *Wings*; but for the Relation that he is a curious *Singing Bird*, I think it untrue. An *Indian Saggamore* is not in his full Pomp and Bravery without one of these Birds in his Ear for a *Pendant*. He is called the *Hum Bird* or *Humming Bird*, because some say he makes a Noise like a *Spinning Wheel* when he flies: But I have been many times very near them, both when they hovered, and when they did fly, and I never heard any Noise; besides, their *Body* and *Wings* are too small to strike Air enough to make any Noise. But of this I shall not be positive, because some *Authors* are opposite to me. It is a solitary Bird. I never saw but 2 at a time together, *viz.* the *Male* and *Female*; they being easily known when together, the *Male* being somewhat bigger than the *Female*.

If one take a *Small Birds Wing*, and stand 4 or 5 Yds from a *Candle* (when dark) and open the *Wing*, and look thro' it at the *Candle*, he may see a most elegant Colour of *Red* and *Green*, which *Green* doth something resemble the Colour of this Bird.

4. Perhaps

4. Perhaps the *Tomincius* does not feed on any Juice he sucks off, or out of Flowers, but rather (like many other Birds) on small Insects, some where-
of lie in the bottom of most Flowers; and for which this Bird hath a Bill,
whereas a Bird that sucks hath a *Sypbon* or hollow Probe.

By Dr. Neh.
Grew, n. 102
p. 87.

XCIII. There is a very great variety of Species in the Parrot kind, whe-
ther we consider the Country, Size or Colour; *Johnston* says, the curious have
observed above an hundred sorts of them. The sixth Species of Paroquets, by
Margravins, comes very near our Subject.

Observations
on the dis-
section of a
Paroquet, by
Mr. R. Wal-
ter, n. 111. p.

Its size is between a Sparrow and a Black-bird, with a short Neck, black
Eyes, a crooked scarlet Bill, greyish Legs and Feet, with Toes two before
and two behind, like the Parrot; yet he never stands on one Foot to Eat
with the other, as Parrots do. When he stands still on the Perch, his Breast
and Belly shew of a curious light green, his Back, and the Feathers of his
Wings are somewhat darker; on his Pinions are some short blue Feathers,
as likewise a pretty many on his Rump. His Bill is encompassed up to the
Eyes with a broad beautiful scarlet Circle, reaching also down to his Throat.
This Place in the Hen is of a paler Orange Colour, wherein is the only obser-
vable Difference. The Feathers of the Tail (which in all small Paroquets is
no longer than the Wings) are not to be seen but when he flutters or spreads
it. They are about two Inches long, near the Quill of a Limon Colour, en-
clining to a Green; next that a Scarlet for a pretty Breadth; then a narrow
Thread of Green on some of them, after that a Black; and last of all end-
ing in a light Green.

451.
History of
8. 451.

Having opened the Thorax and Abdomen (if I may so call them,) by
blowing into the *Aspera Arteria*, a large Cavity or Bladder was raised up
all along the Abdomen to the Edges of the Os Ischion, and fasten'd to the Giz-
zard, containing in it all the Guts and Gizzard, but excluding the Heart and
Liver. A Conformation like this is observed in all Birds, and peculiar to
them, and mentioned by M. *Perault*, the Air received by the Lungs refresh-
ing and carrying off the noxious Streams from the Entrails, is not confined,
as in Men, and Quadrupeds to the Thorax only, by a *Mediastinum*.

Mech. des
Animaux.

The *Aspera Arteria* differs from that of most other Animals, having not
only a Larynx at the top thereof, as is usual, but another also at its Entrance
into the Breast, where it is divided, and Branches it self into two. From
this Structure, as I have been told, common to all Parrots, possibly it may
be, that they can so readily imitate human Voices; but this Creature we
Dissected, never attempts an Imitation of Words, making only a shrill
chirping Noise, doubling the Tone, or making it 8 Notes lower, as a stopt
Organ Pipe is an Eighth to the same Open. This lower Larynx may assist
the weak Fabrick of so small a Creature as a Parrot, to counterfeit so Bass
a Voice as a Man's; it being observed by some ingenious Persons, that
Parrots are Ventriloqui; and that it may be Queried, whether all Ven-
triloquous Cheats may not by Nature be framed for such an Impos-
ture.

The

The Heart in Proportion to the Animal, was large, and the Liver small.

The *Tongue* was broad and thick, at the End somewhat like a Man's; whence a *Parrot* has its Name *ἀνδραπύγων* ♂: the Extremity of it was armed with a Horny Cover.

It has, besides the *Gizzard*, 2 *Craws*, the uppermost *Craw* being only a Receptacle or Sack for the Food (which is *Canary-seed*) to be again committed to the Mouth of this Bird, where it is again chewed, having before been only husked; this Animal ruminating as some *Quadrupeds* do; and I have observed this Bird, when upon the Perch, not only bring its Food again up into its Mouth, and there chew it, but when the Cock and Hen sit together on the Perch, he will put out of his into the Hen's Mouth. Their manner of chewing is thus, the under Bill being much shorter, shuts within the upper, or against the Roof of the Mouth, which is fitted with several rows of very small and scarce to be seen Cross-bars, as the Mouths of Horses, Dogs, and some other Animals are; these Bars are not soft, but horny, as being part of the upper Bill, so that the Bird by carrying the Edge of the under Bill and End of the Tongue against the Ridges in the upper, breaks and reduces to a Pap the Seeds that have been first moistened in the *Craw*, to expedite which Action, the upper Bill is jointed just below the Eyes. The Food being thus macerated, is by the *Gula* again committed to the second *Craw*; but before its Entrance into it, it passes by an abundance of small *Glands*, placed in that part of the *Gula*, that the Food may squeeze out of them in its Passage a Juice; of what Necessity in Digestion may be enquired. From hence the Food passes into the *Gizzard*, or proper Ventricle, small in Comparison of the *Ingluvies* or Crop; where, by several Stones pickt out of the Sand given it, by the Motion of the *Gizzard*, it is comminuted, and thence transmitted to the Intestines, on the Sides of which, within a small Distance is placed the *Pancreas*.

The Explanation of the Figures. *a.* The *Aspera Arteria*. *b.* that part which forms, as it were, another *Larynx*. *c.* Part of the *Gula*. *d.* the upper *Craw*. *e.* the Heart. *ff.* the *Vena axillares*. *gg.* the *Fugulars*. *h.* a small *Gland* on one of them. *ii.* the 2 *Auricles* of the Heart. *kk.* the Liver. *l.* the *Gizzard*.

Fig. 241. *a.* The *Trachea*. *b. b.* the *Larynx*; by which *Parrots* are rendered *Ventri-qui*. *cc.* the 2 Branches of the *Trachea*.

Fig. 242. *a. a.* The *Cornua* of the *Os Hyoides*. *b. b.* two Muscles of the *Larynx*. *c.* the Fissure, or *Glottis*. *d.* the *Trachea*. *e.* the *Tongue*. *f.* the Horny End thereof,

Fig. 243. *a. a.* The *Testes*. *b. b.* the *Deferentia*. *c. c.* the *Kidneys*. *d. d.* the *Ureters*.

Fig. 244. *a.* The Upper Part of the *Gula*. *h.* the first or upper *Craw*, *c.* that Part of the *Gula*, whose Inside is Glandulous. *d.* the lower *Craw*. *e.* the *Gizzard*, or *Ventricle*. *f.* the first *Intestine*. *g. g.* the *Pancreas*.

Fig. 245. *a.* The upper Bill, *b.* the Inside of it. *d. d.* the upper Jaw. *c.* the Place where the upper Bill is moveable. *e.* A Passage to the Nostrils. *f.* the Lower

Lower Bill. g. the upper Bill in another Posture, to shew the small Ridges therein.

XIV. The *Ostridge* is esteemed the largest and tallest of winged or Feathered Fowl, as being sometimes 8 Foot high : Which Bulk, if we compare with the *Tomine jo*, or *Humbird*, weighing about 12 Grains, we may readily discern within what Compass and Latitude the Creation of Birds was ordained.

The whole Foot of this Bird, *a Calcaneo, ad extremum Digitum*, is $\frac{1}{2}$ of a *Tard*; upon which he sits when he rests himself; But the Foot properly so called, or longest Claw is only $\frac{1}{4}$; the lesser Claw $\frac{1}{4}$ and half a Nail. The Nail upon the longer Claw is a Nail long : Above which stands one above another 63 large Scales, reaching up along his Foot before, or before those Bones which answer to the *Metatarsus*. The lesser Claw hath no Nail, and only 8 or 9 Scales one above another, which reach no higher than the Claw itself. The Grain of the Foot is like the Grain of the Skin of an Elephant, but not so very hard, and is moveable, and gives way upon Pressure like the Foot of a Camel; there being Fat under-it, whereby he treads soft, and without Noise : But higher than the two Claws the Skin looks scaly. Every small Scale constituting an irregular *Pentangle*, *Quadrangle*, and sometimes *Hexangle*.

observation on the Dissection of a Ostridge, by Dr. Edw. Brown, Ph. Coll. n. 3. p. 147.

From the Heel to the Knee, or that Part of the Leg which answers to the *Tibia* in Man, it is $\frac{1}{4}$ of a Yard. The Thigh above $\frac{1}{4}$ and very thick.

Upon the *Breast* there is a hard callous dark Substance, of an oval Figure, a Nail and a half in Length, like to that of a *Camel*, upon which he rests himself when he sits, with his Head upright; and in that Posture I think he sleeps, for we could never see him in any other. His *Wing* is too little to cover all his Neck. There is also a callous Part upon the *Os Pubis*, longer than the former mentioned, but narrow; upon which, together with the callous Part upon his Breast, he rests himself. The Length of his Body from the lower Part of the Neck to the End of the Rump, is one Yard; the longest Bone in his Wing is $\frac{1}{4}$ of a Yard, and his Neck a Yard, not measuring the Head with it.

The top of the Head is flat, in length $\frac{1}{4}$ of a Yard, measuring from behind the Head to the End of the Bill. It seems to be hairy rather than covered with Feathers, but the Neck hath beautiful white Feathers, contrary to what some affirm. On the top of his Head there is a flat Oval Place, a Nail in Length, which is all callous, and without any Hair, or Feathers, like the callous Part of his Breast, but not so thick, to preserve the Brain from the *Serenes* that fall in hot Countries, and other Injuries of the Air, especially in the Night, and the more considerably, if he sleeps with his Head upright, and not under his Wing.

The *Gula* is very large, as well as long, but largest at the top near the Head : Where it is a Nail and a half broad. The *Os Hyoides* stretcheth

itself down on each side of the Neck, the Length of $\frac{1}{2}$ of a Yard and half a Nail.

Besides the many *Muscles* in the Neck, for the Motion of the numerous *Vertebrae* and the *Head*, there are two most elegant *Muscles*, which come from within the *Thorax*, arising within the Chest about the 2d. Rib, which insert themselves on each side of the *Aspera Arteria*; these I may name *Directores Aspera Arteria*. At the first dividing of the *Aspera Arteria*, or its *Divarication* on each side of the *Lungs*, there is a Ring bigger and stronger than any other Ring of the *Wind pipe*. There are divers *Glandules* in the Neck near the *Gula*, these are of a pale Colour like Ashes, but there are two most beautiful *Glandules* sticking to the *Carotidal Arteries*, as they come out of the Breast, one on each side, these are blueish.

The *Peritonaum* doubles and encompasses the *Stomach* loosely. He hath 7 Ribs, and the *Intercostal Muscles* are broad, plain, and beautiful. He hath no Prominent Breast bone, like other Fowls, nor a narrow Chest like many *Quadrupeds*, but a broad Breast, and a large firm *Sternum*, of the Shape of a Shield, broader than the *Sternum* of a Man; and indeed when he puts down his Head, and bends his Neck round to come in at a Door, his Breast is so broad, and his Tread so different, that it is not at all like the Entrance of a Fowl, but wonderfully like that of a *Camel*, but with this Advantage, that the *Ostridge* bearing his Weight upon two Legs only, his Entrance is more bold and graceful.

The *Penis* was about an Inch long, with a small cartilaginous Substance in it, the *Testes* lie very high, near the Kidneys and Back-bone, and were very small and slender of a yellow Colour.

The Ear is round, and the Orifice will receive ones Finger; the Eye is large and blueish, and almost as big as a Man's.

The natural Colours of the Feathers of this Fowl were White, Grey and Dun; the Feathers of the inside of the Wings, upon Breast, and Belly, and Neck, were White, and the Feathers in the Tail also White, but the rest are Greyish, or of a Dun Colour, yet it is a most beautiful Creature surely in *Barbary*, where the Heat of the Country crisps and curls all its Feathers.

The *Rimula* of the *Larynx* is long, and the Cartilages about it strong, but no *Epiglottis*, or likeness to a Human *Larynx*, although they that heard its Voice, compare it to the Crying or Shrieking of a hoarse Child, but more mournful and dismal. the *Lungs* are of fine florid Colours, but little in Proportion to the vast *Aspera Arteria*, they stick close to the Back, and are perforated like other Birds: And upon blowing into the *Wind pipe* with a Pair of Bellows, we could not make them rise or fill. The Heart hath two Ventracles, about the Bigness of a Man's Heart, but the right Ventricle is much thinner, and the Valves are more fleshy.

There are two *Stomachs*, as in Granivorous Fowls, a *Crop* and a *Gizzard*, but the *Crop*, or first *Stomach*, differs much from that of other Fowls, in that

that it is not placed without the *Breast* but within the *Sternum*, in that it is not round but longer like a Bag, and of a vast Bigness, lying lengthwise in the Body. We found many *Glandules* in the Coats of this *Stomach*, a Row of them on the back Part of it, reaching almost from one End to the other, about a Thousand of them, about ten in Breadth, and an Hundred in Length. These lie between the Coats of the *Stomach*, and every particular *Glandule* discharges it self by a peculiar Orifice, thro' the inward Coat of the *Stomach* into the Cavity thereof. We found some of these *Glandules* round and Globular, some oval, and some more flat, and of an irregular Figure; those which lie highest are roundest and thickest; those which lie more towards the Bottom of the *Stomach*, or where it unites with the *Gizzard*, are more broad and flat. These bring in a Juice which helps to digest that various Nourishment which the Fowl makes use of. The *Gizzard* was very large, the inner Coat did not adhere so firmly as in other Fowls, and was very thick and like *Flannel*, and upon our first looking into the *Gizzard*, from the first *Stomach* it appeared as a Piece of *Flannel* or *Napkin*, which the *Osfridge* had swallowed, and so stuck there. The Passage out of the *Gizzard* into the small Guts is very streight.

The Guts are about 20 Yards in Length, the smaller Guts beginning from the *Stomach* are ten Yards long; and the larger Guts down from thence to the *Anus*, are near as much. At the Beginning of the great Guts there are two *Intestina Cæca*, each of them a Yard long: And they have a Scrue or *Spiral Valve* within them, after the Manner of the *Cæcum* of a *Rabbit*, this Scrue in both in the *Intestina* winds about 20 Turns. The Extremity of the *Cæcum* is little, not much differing the *Cæcum* of a Man. The Excrement, which is thrown out by the Guts, is of two Kinds, a white, thin, sticking Excrement, which it mutes like a *Hawk*, and after that, another sort of Excrement comes, which is very like to that of a *Sheep*, but bigger.

The *Mesentery*, although it holds together such a Number of Guts, great and small, yet it is not thick, but is only a transparent Membrane, as generally in *Pennates*; but it is very large, and in some Places above $\frac{1}{2}$ of a Yard deep or broad, measuring from the Center to the Guts.

The Liver hath 4 Lobes, and is of a Colour not much different from that of a Man's, we could find no Bladder of *Gall*. There was a *Glandule* under the *Stomach*, which might seem to be a *Spleen*: But *Pennata* and *Insecta* are said to have no *Spleens*. The *Pancreas* was slender, and above a Foot long. The Kidneys are large, and of the length of my Hand, as they lie both together, they are of the Shape of a *Guitar*. The *Ureters* are firm, strong, white, and long. Behind the Kidneys lie two *Glandules* somewhat oval, of about an Inch and half in length, close to the Back-bone.

The Head resembles that of a *Goose*, and is little in proportion to the whole Body.

In *Africa*, where some make Meat of *Elephants*, it is no Wonder if some also feed upon *Osfridges*; but *Galen* and Physicians condemn it as hard of Digestion.

The Cuntur
of Peru, by
Dr. H. Sloan.
n. 208. p. 61.

XCV. The *Magnitude* ascribed to the *Cuntur* or *Condor* of *Peru*, as well as its great Force and Strength, have been the Cause that many have doubted its Being. Capt. *John Strong*, Commander of a Ship which went into the *South-Seas*, through the *Streights* of *Magellan*, and returned after 23 Months Voyage, in the Year 1691. gives me this Account, together with the Wing or Quill-feather of the Bird, viz. That on the Coast of *Chili*, they had met with this Bird in about 33° S. Lat. not far from *Mocha*, an Island in the *South-Seas*, and before they came at a Place called *Herradura*, that his Men were very much amazed at the Bigness of it, and that after they had killed it, it was 16 Foot from Wing to Wing extended. The *Spanish* Inhabitants there told them, it was the *Cuntur*, and that they were afraid of these Birds, lest they should prey on, or injure their Children. The Feather he gave me is 2 Foot 4 Inches long, the Quill-part is 5 Inches $\frac{3}{4}$ long, and an Inch and half about in the largest Part, it weighed 3 Drains 17 Grains and half, and was of a dark brown Colour, very hollow or concave on one Side, and convex on the other. The *Seamen* shot it sitting on a *Cliff* by the Sea-side, and eat it, taking it for a sort of *Turkey*, in which Mistake likewise, the first Comers to *Jamaica* were with a Bird in that Place, called a *Carrion-Crow*, which is a sort of *Vulture*, of which kind, I believe this also is.

Observations
on the
Heads of
Fowl, by
Dr. Ail
Moulen, n.
192. p. 711.

XCVI. 1. In the Heads of all Fowl that I have had an Opportunity to examine, I constantly found only one *Aqueductus*, or Passage from the Ears into the Palat, whereas in Men, *Quadrupeds*, and some *Amphibious* Fish, there are always two. This Passage in Fowl is exactly in the middle of the Palat, below the Entrance of the Nostrils into it. It is a Membranous Tube, capable of admitting a *Raven's*, if not a *Goose* Quill in larger Fowl, such as *Turkeys*, *Geese*, &c. and reaches backwards as far as the Communication from Ear to Ear: And hence it comes to serve both, whereas there is a Necessity of two in those Animals, whose Ears do not communicate.

2. I constantly found a hollow Space between the two Tables, between the Os *Cuneiforme* reaching from Ear to Ear, and as far forward as the afore-said common *Aqueductus*, or rather *Ductus Aereus*, the Contrivance of it seeming more to favour this than the former Use. This Cavity in all Fowl (as far as I have observed) reaches above the *Labyrinthus* on each side; so that whatever Impulse is made on the *Tympanum* on the one side, may not only be very readily communicated by Means of the Internal Air to the *Labyrinthus* of the same, but also to that of the opposite Side. Hence probably proceeds the Quickness of Hearing, and Vigilancy of Fowl, notwithstanding their wanting a *Cochlea*; the Defect of which seems to be by this Structure more than supplied, no other Creatures that we know of having any Thing of it. There are several *Laminula*, and Pillars of hard Bone between the two Tables in these Cavities, designed, as may be supposed, partly

partly for their Maintenance at a convenient Distance, and partly for breaking of the *Air*, so as to hinder *Eccboes*, and confused Representations of Objects, as it hath been ingeniously observed by Sir J. Hoskins, That Pillars in Churches very much *Eccboes*.

3. In the Heads of *Woodcocks*, beside the Passages now described, I found one on each side the Bone, making the Orbit of the Eye, proceeding from the Ear, and reaching forwards towards the setting on of the *Beak*, near which they joined in one, and turned under the Skull in a small Passage leading to the Cavity, by which the *Ears* communicate, and which is above described, into which it enters. These Passages are also in the Heads of *Snites*, and moreover one over the *Sinus longitudinalis*, and another over the *Sinus lateralis* of the *Brain*. Note, That in the killing of *Snites*, and smaller Birds, if Care be not taken that the Head be not bruised, these Passages cannot be discovered for Blood extravasated in them. Note also, That the *Laminula*, and *Bony Pillars*, are every where to be observed where there is a Passage, excepting under the Skull, in the Passage from the setting on of the Bill to the first Passage described.

4. In the Heads of *Parrots* and *Paroquets*, besides the first describ'd Passage, I observed, between the two Tables, every where Cells opening into others, and those into others, so that there was not any Part scarcely of the Skull that was not taken up with them. And this did not only appear by pouring into one Ear, freed from its *Drum*, the other also being removed, a *Tincture* of *Cochineel*, and then blowing of it into all these Cells, so that no Part was free from *Tincture*, but it appeared also to the naked Eye, notwithstanding that sometimes it was difficult to trace the Communications of them, by Reason of the Numerousness of the *Laminula*, and Pillars aforesaid.

5. In *Singing Birds*, the Structure of these Passages is like that of the *Parrot* and *Paroquet*, only that the Pillars and *Laminulae* are less than they should seem to be in Proportion to the Heads: From whence it is probable, that these Birds are by this Structure enabled to distinguish *Sounds* and *Notes*, and also imitate them better, having a more musical Ear.

6. In the Heads of *Pullets*, *Geese*, and *Ducks*, I found only the first described Passage distinctly: But in *Plovers*, *Bustards*, and some other, I found another that went over the *Sinus lateralis* of the *Brain* from *Ear* to *Ear*. This seems to be designed to make them more watchful than *Domestick Fowls*, or than those that live much on the Water, because they are liable to a great many Dangers that the others are exempt from.

7. In the Ears of all the Fowl that I could examine, I never found any more than one Bone and a Cartilage, making a Joint with it, that was easily moveable.

The Cartilage had generally an *Epiphyse* or two on each Side, which were very flexible as it self was. The Bone was small and very hard, having at the End of it a broad Plate, of the same Substance, very thin, upon which it rested as on its Basis.

8. I observed three Pair of Nerves in all the Broad-bill'd Birds that I could meet with, and in all such as feel for their Food out of their Sight, as *Snites*,
Wood-

Woodcocks, Curlews, Geese, Ducks, Teale, Widgeon, &c. These Nerves are very large, equalling almost the *Optick Nerve* in Thickness ; they begin a little more forward than the *Auditory Nerve* from a little Protuberance which seems to be made for them. One of them goes over the *Optick Nerve* in the Orbit of the Eye ; the other two go under the Eye ; two are distributed nigh the End of the upper Bill, and are there very much expanded, passing through the Bone into the *Membrane*, lining the Roof of the *Mouth* : the third Pair is distributed near the End of the lower Bill, and subdivided like the former. *Note*, that Birds that pick their Food where they can see it, have not these *Nerves*, and that the Pair of *Nerves* belonging to the upper Bill, is considerably smaller in Proportion to the Fowls, than those observed above, whence it is probable, that these *Nerves* are designed for some great use, both on the Account of their Number and their Largeness, and that the use to be assigned to them, must be to enable them to distinguish (whether by *Tasting* or *Feeling*, will not now determine) their Food, there being a Necessity of a more exquisite Sense in these *Fowl*, than in any other.

Fig. 246. The 246 Figure represents these in a *Duck's Head*, where *a a* expresses the Edge of the *Cranium*, which is in Part removed for the more clear View of these *Nerves* ; *b b.* are the Cells about the *Ear*, between the two Tables above described ; *c c.* the *Brain* laid bare, with its *Blood-Vessels* ; *d d d.* the three *Nerves* on one side ; *e*, the *Optick Nerve* ; *fff* the *Skin* and Part of the Bone removed, to bring the *Nerves* in View ; *g g.* the two *Nerves* expanded near the End of the upper Bill ; *h h.* that in the lower.

9. All the Eyes of a *Fowl* and of *Fish*, that I have examined, were more or less cartilaginous, for the *Sclerotis* is a *Cartilago sui generis*, especially near the *Cornea*, in all these Animals. And in the larger sort of both, I remember to have found the whole *Sclerotis* such a Kind of a *Cartilage*.

10. I have frequently observed in smaller *Fowl*, that the *Membrane* of the *Drum* was double, for by gently pulling away the *Membrane* lining the *Tube* of the *Ear*, I have observed at the bottom of it a transparent *Membrane* ; which at first I took to be the *Membrane* of the *Drum*, put upon Examination, I found that the *Membrane* of the *Drum* was still entire, and in its proper Place. I have also sometimes observed this in larger *Fowl*, in a *Seal*, and in some other Animals, and perhaps it may be so in all.

By Mr. J.
Clayton, n.
206. p. 990.

2. *Dr. Moulen* and my self, when we made our Anatomies together at *London*, shew'd to the *Royal Society*, that all flat-bill'd Birds, that Groped for their Meat, had three Pair of *Nerves*, that came down into their Bills ; whereby, as we conceived, they had that Accuracy to distinguish what was proper for Food, and what to be rejected, by their Taste, when they did not see it. This was most evident in a *Duck's Bill* and Head, a *Duck* having larger *Nerves*, that come into their Bills than *Geese*, or any other Bird that I have seen, and therefore *Quaffer* and *Grope* out their Meat the most. But I then discovered none of these *Nerves* in round bill'd

Birds :

Birds: But since, in my *Anatomies* in the Country, in a *Rook* I first observed two *Nerves*, that came down betwixt the Eyes into the upper *Bill*; but considerably smaller than any of the three pair of *Nerves*, in the *Bills* of *Ducks*, but larger than the *Nerves* in any other *Round-Bill'd Birds*. And 'tis Remarkable, these *Birds* more than any other *Round Bill'd Birds* seem to Grope for their Meat in Cow-dung, and the like. Since I have found in several *Round-Bill'd Birds*, the like *Nerves* coming down betwixt the Eyes, but so very small, that had I not first seen them in a *Rook*, I should scarce have made the Discovery. In the lower *Bill* also there are *Nerves* that have much the same Situation with the *Flat-bill'd Birds*, but very small, and scarce discernable, unless to the cautious and curious.

The *Ears* of *Birds* differ much from those of *Men* or *Beasts*, there's almost a direct Passage from one *Ear* to the other of *Birds*. so that prick but the small Membrane called the *Drum* on either *Ear*, and Water poured in at one *Ear* will run out at the other. But what is much more remarkable, they have no *Cochlea*, but instead thereof, there's a small *cochlearous* or *twisting Passage* that opens into a large Cavity, that runs betwixt two Skulls, and passes all round the Head. The upper Skull is supported by many Hundred of small thread-like Pillars, or *Fibres*, which, as we supposed, had another Use also, viz. to break the Sound from making any confused Echo, and to make it one, and distinct. This Passage we observed was much larger in *Singing-Birds*, than in others that do not Sing, so very Remarkably, that any Person that has been but show'd this, may easily judge by the Head what *Bird* is a *Singing-Bird*, or has Aptitude thereto, tho' he never saw the *Bird* before, or knew what *Bird* it were. This has often made me reflect how much the *Modification* of Voices depends upon the *Accuracy* of the Ear, and how Deaf Persons become Dumb: And since, I have observed that many Children that have an acute Wit enough, that are slow of Speech, that is, long before they speak, are much longer before they can pronounce those Letters that are sharp, as *g. b. r.* and never have an Aptitude to learn to sing.

I have also anatomized most sorts of Creatures, and never found any Four footed Creature with an *Ear* like a *Bird*, unless a *Mole*, and *Mole* has an *Ear* much like them, with a very thin double Skull, and a great Cavity like a *Bird*, and is very acute of *Hearing*. The Skull by reason of this large Cavity, being very slender, is easily crushed; so that a *Mole* is quickly kill'd with a bruise on the Skull, like a *Lark*, and upon the bruise, the Membranes of the Skull turn black; but when I have taken Care not to bruise the Skull the Membranes were not black at all.

XCVII. I have observed, by Inflation into the *Aspera Arteria* of *Fowls*, that there is a Continuation of many *Vesicles* extended from the *Bronchie* through the *Abdomen* to the *Anus*. This, I conceive to be the Cause of the constant Motion of the *Anus* in *Fowls*, the Air having Ingress and Egress there: And also that to be the Reason why the *Anus* of *Fowls* are in ma-

The Anus of Fowls applied in malignant distemper, by Mr. J. Tomlinson, n. 86. p. 5031.

lignant

lignant *Distempers* applied to draw the Infection out of the *body*. For those *Ann's* being like *Cups* or *Ventouses*, the fowl has often stuck by its *Ann's* till it died, in which Case, I have known 7 Chickens applied to the Groin of one visited by the *Plague*, that stuck till they died, and the Eighth went quickly off, and lived above 1½ Year after.

A Blemish
peculiar to
the Eyes of
Horses, by
Dr. Rich
Lower, n.
32. p. 613.

XCVIII. 1. The *Eyes* of *Horses* are peculiarly affected with one Defect, which no *Animal* besides is troubled withal, as far as I have observed; and that is, a spongy Excrecence (commonly of a dark musk Colour) which grows out of the Edge of that Coat of the Eye, called the *Uvea*. If this spongy Substance be so great, or the Number of them such, as that they grow in several Places about the *Pupil* of the *Eye*, where it contracts it self, the *Pupil* or *Sight* is very much (if not totally) obstructed; and consequently, the Horse sees very little, or nothing at all. As I have many times taken notice in some Horses, which being brought into the Sun shine, could not see at all, but suffered me to touch the Sight of their Eye with my *Finger* without the least Winking, which Horses being led back into the *Stable*, the *Uvea* in that obscure Place, dilating it self, they could see very well again, and would not suffer me to shew my *Finger* near to the Eye, without frequent closing their Eye lids, and tossing their Heads. The same Horses I understood by the Owners, were very apt to stumble in the Day time, if it were bright and Sunshine, but travelled very well, and securely in the *Evening*, and in dark cloudy Weather.

I cannot think that these Excrecencies come from straining in great Draughts, and Races, or from hard Travel: Because I have seen very large *Sponges* (as I may call them) in young Horses Eyes of 2 and 4 Years old, before they were backed; which, after they have been taken up from the Grass, and kept with dry Meat, have very much abated and afterwards being turned to Grass in the Spring to cleanse and cool their Bodies, have encreased again to the wonted bigness.

It is remarkable, that the more and greater those Excrecencies are, the more the *Pupil* of the *Eye* or the *Sight* is in Danger of being quite obstructed, which you may further examine, by turning the Horse's Eye to the *Light*, and observing how much of the *Pupil* they do obstruct. That those on the upper Edge of the *Uvea* are apt to grow the largest, and hinder the *Sight* most. And that that which grows on the middle of the *Uvea*, does more hinder the *Sight*, by distracting the Object, than that, which grows in either Corner or Angle of it.

I suppose no Cure can be expected but from a drying Kind of Dyet; yet perhaps outwardly something may be Devised to shadow the *Eyes*, and keep 'em from being Nakedly Exposed to the Sun, whereby the *Pupil* will not be so closely contracted, and consequently, the *Sight* not so much obstructed.

By . . . n.
37. p. 750.

2. Horses of an *Iron Grey*, or *Dapple Grey*, are frequently inclining to lose one or both Eyes, if Back'd or hard Ridden too soon.

In

In Man and Beast. (in Horses at least) the right Eye is the weakest, and most frequently failing.

The *Pupil*, or Black of the Eye is wider and larger in those that are short-sighted, than in those that see at greater Distance.

I have often noted some that are short-sighted, I say not pur-blind, to discern all things that are done about them, almost quite behind them, more perfectly than the best sighted, if the Room was not too large for the Reach of their Sight.

Also some of Dr. *Lower's* Observations I could confirm by my own Experience. In my youngest Days, I had a very narrow Escape from an excellent Horse, which had that only Defect, which they call *Moon-blind*, (and they told me of it after the Mischeif:) I purposed to leap a Ditch, but the Horse saw no Ditch, so we fell in together.

As Coach and Cart Horses have Flaps on the Ear sides of their Eyes, so these Flaps may be fitted (and in some Shew of Ornament) to shadow the over Part of the Eyes, and yet to afford them Light enough to see their Way. I know not whether it be usual amongst you, but I have seen a young Child wear a kind of black Ribbon, like a narrow *Mask* before her Eyes, the Ribbon or *Mask* having Holes made in fit Places to guide the Eye: And this was said to be an effectual Remedy to cure the Child of Squinting, which she had hereditarily from her Mother.

XCIX. Duodecimus jam excurrit Annus, quo maestandum bovem lustravi cum præclarissimis Viris D. *Carolo Fracarsato*, & D. *Silvestro Bonfiliolo*, a cuius Collo in dextris, ubi jugum apponitur, insigne pendebar Cornu. Hujus Longitudo 16 *Digitorum* crassitiem æquabat; Non longe a Basi ubi Latius erat, 8 *Digitorum* Latitudinem explebat. Ejus forma conica erat, & in obtusum deducta Apicem, non parum versus Finem curvabatur. In Basi tamen, ubi Collo necebat, arctius erat. Color circa extremitatem subniger Lucidusque erat; & persimilis ei, qui in *Ungula Bubula* passim observatur. Exterior *Superficies* aspera erat, præcipue a Basi usque ad medium; etenim Cuticula & subiectum *reticulare Corpus* cum contentis *Papillis* (quæ in aliis partibus perpendiculariter attolli solent, ac *Tactus Organum* constituunt) sensim produci inclinarique incipiebant, non dispari specie, ac in nostrorum *Digitorum* extremitate, quilibet prope *Unguium* Radicem observare potest. *Papillæ* igitur, Laciniata Cuticula, & reticulari Corpore circumdata, majorem Longitudinem sortitæ ita inclinabantur, & invicem hærebant, & ferruminabantur extremis Finibus, ut squamosum *Piscium* Tegumentum æmularentur. Circa Basim squamosa hæc corpora breviora erant, sensim vero producta, & prope Comm longissima reddebantur. Varius quoque erat Substantiæ Modus; nam in Basi *Papillaria* hæc Corpora non ita sibi mutuo connexa conglutinabantur, sed solutis ipsorum Finibus laciniatum & asperum excitabatur Corpus. Ultra tamen Medietatem densiori donabantur compage, unde & lucida & levia videbantur. Interius expositum cornu concavum erat, ita ut Crassities ipsius in Basi nativam *Corii* altitudinem parum excederet; gracilesciente tamen & attenuato *Corio* ad Naturam quasi Mem-

A Horn hanging at the Neck of an Ox, by S. Malphigi, n. 166. p. 601.

brana intus ambebat, quod *sanguinea vasa* irrigabant; hocque detracto solidum & leve corpus occurrebat. Tota Concavitas referta erat subflavo, turbidoque sero, quod igni appositum totum fere in Naturam Albuminis Ovi concresebat. Sub Basi Glandulæ conglobatæ, depressæ tamen insigniter, luxuriabant.

Ex hujus igitur diligenti Inspectione patet, *Papillas* (quas non incongrue externi *Tactus Organa* credidi) *Cuticula & Reticulari Corpore* custoditas, ubicunque plus justo producantur, & invicem intime unitæ ferruminantur, in solidum definire Corpus; quod commue est *Ungulis & Cornubus*, quæ sola exteriori Configuratione, & majori minorive Partium densitate donata, ad invicem discriminantur; unde veluti Sensorii Additamentum censenda veniunt, & Tactui quoque non parum conducentia. Cornuum e Cranio erumpentium observata Productio his multum lucis confert. Hanc itaque Vegetationem in Bove deprehensam in Physicæ additamentum audire ne graveris.

In *Fetu*, igitur adhuc in Utero contento, *Cranii Os* in situ Cornuum fere Cartilaginem est, & postremo Osseam Naturam acquirit. *Pili* ibidem primo erumpunt Glabro existente Corio præter Labia, quæ quibusdam *Pilis* ornantur. Hi taliter locantur, ut ipsorum Ordines a Circumferentia versus Centrum situati & inclinati minimum quasi Conum efforment. Postremis quoque Mensibus, in *Fetu* adhuc concluso, *Osseæ Lamellæ* (quibus Cranium compaginatur) obliquari incipiunt, & fracta Directione extra imminet, excitatis intro subrotundis spaciolis, unde supra Cranium osseus tumor primo emergit lenticulare corpus præ se ferens. Hoc extenso Corio cooperitur, quod præ reliquis crassum est, & turgentes exhibet *Glandulas* Inter osseum Corpus & Corium, *Periosteon*, seu *Osseæ Substantiæ* inchoamenta locantur, quæ paulatim manifestantur. Extra Uterum sensim osseus Tumor lenticularis parum assurgit turgentibus osseis Lamellis. Supra Os crassum luxuriat *Periosteon*, seu futuri Ossis Inchoamentum. Corium quoque obducitur, a quo *Tactus Papilla* assurgentes reticulari & cinereo Corpore ambiuntur: Hoc copiosis *Pilis*, diversam Inclinationem sortitis, cooperitur. Altero elabente Mense, *Osseæ Substantia* Laminulis & spaciolis contexta extuberat, ita ut Cornu rudimentum emergat, dimidiam *Digiti Crassitiem* æquans, & Conoidem Parabolicum representans. Hujus exterior Superficies lævis & glabra sensim redditur, nigroque inficitur Colore. Corium crassum de more extenditur, a quo *Tactus Papilla* erumpentes, superato *Reticulari* Involucro, quod Cinerem est, elongantur, & nigro ambiente Succo conglutinantur. Hæ circa Cornuum Basim inclinatæ versus Apicem diriguntur: Reliquæ vero ab Apice exortæ Perpendiculares quasi assurgunt, & *Reticulari* Corpore custodiuntur; earum Longitudo vix *Serici Villosi* Lanuginem æquat. Interea inclusa osseæ Appendix Augmentum capit, & Interius varie Configuratur. Etenim ut plurimum Radix Fistulosa excitatur Substantia quæ Oessis Fibris reticulariter implicitis componitur; reliquum vero usque ad Apicem Spongioso constat Corpore. Sanguinea intercurrent Vasa, & A-

pex perpetuo *Submollis* firma Partium compage non gaudet. *Corium* quoque extensum *Offeam* Substantiam investit, & in basi Crassius est. Ab hoc itaque immergentes *Tactus Papilla* ita Proceræ redduntur, ut inclinatae versus Apicem, simulque *reticulari Corpori* unitæ, tot *Conica* Corpora concava efficiunt, & ex horum unione (quasi tot *Lamellis*, *Ceparum* instar, intra se positis) solidum Cornu corpus efficiatur. *Papillarum Ordines* in basi erumpentes licet non omnes Apicem attingant, ut plurimum tamen recta deducuntur, & fere Cornu ambiunt; alia quoque sub diversis Planis a producto Corio propagantur, quæ longiores redditæ breviores cooperiunt & includunt, unde secto per longum cornu non solum *Offea* substantia occurrit, sed etiam *Corium* a quo molles *Papillæ* emanant, quæ in *Cornuum* Substantiam immutatae solidescunt & nigrescunt, avulsoque osse cum ambiente corio, *Fistula* in cornu a *reticulari opere* excitatae patent. Occurrunt quoque *papillarum tactus* varii exortus & plana, ipsarumque Productio usque ad Apicem; unde cum diversa plana extremum *cornum* constituent, hinc est, quod Apicis substantia crassitiem fere digiti æquat. *Exarata Papilla* basim cornuum excitantes molles adhuc sunt, & de facili lacerantur, vel in furfures abeunt: circa finem vero & apicem ita addensantur, & *reticulari corpore* ferrominantur, ut solidæ factæ *nigro lucidoque* inficiantur Colore. Harum progressus evidens est; nam tot quasi Filamentis, per longum ductis, coagmentari videntur.

Procerioribus redditis *cornubus*, ita ut 12 *digitorum* crassitiem æquent, inclusa Appendix *Offea* longior redditur; & ubi continuo & pleno Osse non coagmentatur, variis *cellulis* concameratur & excavatur. Secto autem Cornu per longum, singula dilucidius patent: primo enim frequenter *exarata Appendix* *offea lamina* componitur, ita ut *Tubus* efficiatur: Portiones tamen *ossæ oblique* per transversum ductæ inferuntur, unde relictæ *Areæ* concavitates oblongas, inæqualis tamen Longitudinis & Figuræ, efficiunt: in quibus alia quoque ab assurgentibus parum *Osseis Parietibus* designantur. Omnes hæc Concamerationes Membrana tenui obducuntur, sub qua sanguinei *Vasa* in miras Propagines diramata custodiuntur. Versus Apicem *Offea substantia* spongiosa est nullis *Cellulis* excavata, unde impense rubet ex innumeris *Vasculis*, quibus irrigatur.

Expositam Appendixem *osseam* extenuatum *Corium* ambit, a quo molles de More *Tactus Papilla* emanant, quæ *reticulari corpore* custoditæ, simulque ferruminatæ, versus Apicem deductæ Cornu componunt, ita ut Cornuum *Parietes* in Basi Graciles sensim ex *Papillarum* Additione reddantur, & tandem in Apice ex omnium Unione, Duorum *Digitorum* Crassitiem æquent.

Horum interior Superficies nigra est, & fistulosis Foraminulis versus Apicem directis exasperatur; quibus *papillæ* admittuntur, Exterior Apex Acuminatus, Solidus, Lucidus, & Ater est; Versus Medium tamen subalbescit Cornu, & circa Basim parum nigrescit, & de facili in Squammas solvitur.

Ulterius tandem Augmentum fortiuntur Cornua, ita ut urgente interi-
ori Ossea Appendice primi *Papillarum* Ordines a Basi erumpentes, avulsi a
Corio separentur, & ita diversi Fines & *Papillarum* Limbi apparent; non
dispari ritu ac in Conchis Marinis conspiciamus, quarum Compositio di-
versis Testulis superpositis, in aequalibus tamen, coagmentatur, ita ut
extremi Fines quarumcunque *Testularum* minimum elegansque exhibeant
planum. Hæc eadem Structura evidenter quoque in *Dorcadis Cornubus* elu-
scescit, unde a Radicibus usque ad Medium Asperitates, quasi Nodi, obser-
vantur, quæ a diversis *Papillarum* Lamellis vario tempore a Corio avulsis, &
fursum retractis excoriuntur, quæ omnia diligenti Microscopii lustratione
parent.

Postremo tandem Cornua ultimum sortita incrementum non parum
immutantur: nam exterius ipsorum Color varius efficitur, Substantia
quoque solidior reddita, Diaphana fere evadit, & continuo Usu læviga-
tur. Interius Ossea Appendix obtuso terminatur Fine, totaque ipsius lon-
gitudinem gracilente Corio adhuc tegitur. Ab hac Emergentes olim *Tactus*
Papilla obliterantur, præterquam in Apice: Interior enim Cornuum
Superficies evanescentibus Vaginulis, seu Reticularis Corporis Finibus,
ex Ferruminantis Succo exundante Copia, tota fere circa Basim Lævis
& Perpolita redditur, ita ut *Papillarum* Productiones quasi obscurentur.

Analogam quoque Generationem in *Gallorum Calcaribus* observamus, quæ
ex Curicula & subjectis *Papillis Reticulari Corpore* conditis conflantur, ita ut
urgente intus Ossea Appendice exterius quoque Corium multiplicibus *Ca-
ticula* involucris obductum rapiatur, & novum quasi cornu, licet minimum
erumpat.

Ex his igitur conjectari licet, Monstruosum Cornu in Bove Ortum
traxisse non tam ex ulteriori *Papillarum*, Corii, & *Reticularis Corporis* pro-
ductione, sed ex conatu interioris Tumoris, & ex Compressione facta
in Cervice a proximo Jugo; in Naturali namque Cornuum Eruptione e-
mergens Ossea Appendix extensam sibi Corii Portionem sensim urget, se-
cutumque rapit, ita ut *Papilla* versus Apicem inclinatz elongentur. Proceri-
ores autem redditæ sunt, in Monstruoso Cornu, *Tactus Papillæ* ex copio-
so fortasse Succo per Filamentorum Reticularem contexturam, qua Co-
rium componitur, excurrere vel elabente in Continuatæ *Papillas*, & in
Muscifum Reticulareque Corpus, ut in Ungularum Vegetatione contin-
git, quæ cum extremis *Papillarum* Finibus excitentur, in Deformem
producerentur Longitudinem, nisi vel Arte, vel Attritu mutilarentur.
Probabile quoque est ex Urgente assidue Jugo proximam Cervicis Partem
compressam & inde Callosam redditam fuisse: Sanguinis namque Motus
non ita feliciter Celebratus est; Ichoris quoque & Lenti Humoris per
exaratam Corii contexturam ulterior Fluxus impeditus est, & Sudoris,
Halitusque Effluvia per propria Sudoris Vascula suppressa sunt, unde
Coriopapillæ ultra Augmentum in novum Situm & Compagem adaptæ
sunt,

sunt & Reticulare Corpus, quod alias *Mucosum* est, pene *Osseum* natum est Consistentiam. Hæc autem Ferruminatio probabiliter contigit ex *Vitriolato Humore* per *Excretoria Sudoris vasa* effluente vel saltem ab *Acidis Effluviis* Coercitis & *Fixis*, dum interim Evaporantibus *Alcaribus* & *Aquosis* Particulis *Sanguinei* instar *Seri Solidum*, *Lucidumque* fere Corpus excitatum est.

C. Sir *Will Lowther* (in *Torkshire*) had a *Lamb* 1694. which, being left by the *Ewe*, Suck'd a *Weather* (*Aries Castratus*) and brought him to *Milk*, and was maintained by him all Summer till the latter End of *August*, that he was *Weaned*. I saw his *Udder* the latter End of *September* each side whereof was about the bigness of a *Hen's Egg*; and he had 2 considerable *Teats*. I saw *Milk* spurted out of them, to a *Yard* or two's Distance. notwithstanding the *Lamb* had been taken from him so long, In *November* I saw him again, but his *Udder* was then much fallen, each side being now about the bigness of a *Walnut*; there is *Milk* still in it, enough to *Stream* out above half a *Yard*.

A *Lamb*
Suckled by a
Weather; By
Mr. Tho.
Kirke. n. 214.
p. 263.

There are no Tokens at all of an *Hermaphrodite* in him. I Compared him with another *Weather*, who had *Teats* or *Paps* like him, and differed in nothing but the *Udder*. The *Ewe* died upon *Shearing*, when the *Lamb* was about five *Weeks* Old; so 'tis likely it might feed partly upon *Grass* as I suppose other *lambs* of the like Age do, notwithstanding what they Suck from their *Dams*.

CI. Dr. *Clark* and Dr. *Lower* have given me an Account of a pretty odd kind of Observation: One of them assuring me, that he had several times in the *Lungs* of *Sheep* found a considerable quantity of *Grass*, in the very *Branches* of the *Aspera Arteria*; and the other relating to me, that a few *Weeks* since, he, and a Couple of Physicians, were invited to look upon an *Ox*, that had two or three Days almost continually held his Neck straight up, and was Dead of a Disease the Owner could not conjecture at; whereupon, the Parts belonging to the Neck and Throat being opened, they found the *Aspera Arteria*, in its very Trunk, all stuffed with *Grass*, as if it had been thrust there by main Force: Which gives us just cause to wonder both how such a quantity of *Grass* should get in there; and how, being there an Animal could Live with it so long.

Grass found
in the Wind
Pipes and
Lungs of some
Animals; By
Mr. Rob.
Boyle. n. 6.
p. 100.

CII. 1. On the Borders of *Italy* a *Murrain* infected the *Cattle*, which spread farther into *Switzerland*, the Territories of *Wirtemberg*, and over other Provinces, and made great Destruction amongst the *Cattle*. The Contagion seemed to Propagate it self in the form of a *Blue-Mist*, that fell upon those Pastures where the *Cattle* Grazed, in so much that whole Herds have returned Home Sick; being very Dull, Forbearing their Food, most of them would die away in 24 Hours. Upon Dissections were discovered large and Corrupted *Spleens*, *Sphacelous* and Corroded *Tongues*, some had *Angina Maligna's* Those

A *Murrain* in
Switzerland
and its Cure
By Dr. Win.
eler. n. 145.
p. 93.

Those Persons, that carelessly managed their Cattle without a due respect to their own Health, were themselves *Infected*, and dyed away like their Beasts. This *Contagion* may probably proceed from some *Noxious Exhalations* thrown out of the Earth, by 3 Distinct *Earthquakes* perceived here and in our Neighbourhood in the space of one Year.

The Method of Cure was thus; as soon as ever there was any suspicion of the *Contagion* upon any one of the Herd, the *Tongue* of that Beast was carefully Examined: In case they found any *Aptba* or *Blisters*, whether *White*, *Yellow*, or *Black*, then they were obliged to rub, scratch and tear the *Tongue* till it *bled*; then they wiped away the *Blood*, and *Corruption* with new unwashed Linen; This done a *Lotion* for the *Tongue* was used, made of *Salt* and good *Vinegar*. The *Antidote* for the Diseased Cattle, and the *Medicine* for the Sick was the same; viz. Take of *Soot*, *Gun-Powder*, *Brimstone*, *Salt*, Equal parts, and as much *Water* as is necessary to wash it down; give a large Spoonful for a Dose.

By Dr. Fred.
Slare. ib. p.
94.

2. I am assured, by two ingenious Travellers, that this *Contagion* reach'd the Borders of *Poland*, having passed quite through *Germany*; That it was observed to make its Progress daily, spreading near two German Miles in twenty four Hours; that it continually without Intermision made Progressive Voyages, and suffered no Neighbouring Parish to Escape, so that it did not at the same time *Infect* Places at great Distances, that Cattle secured at *Rack* and *Manger* were equally Infected with those in the Field. It were worth considering whether this *Infection* is not carried on by some *Volatile Insect*, that is able to make only such short *Flights* as may amount to such Computations.

The Diseases
of Dogs; By
Sir Theodore
Mayern. n.
191. p. 408.

CIII. Dogs are subject to these Diseases. 1. The *Hot Madness*, which is Incurable; they fly upon every thing, and can hold out but 4 days. 2. The *Running-madness*, which is likewise Incurable; they fly only upon Dogs, and that by Fits, and may sometimes hold out nine Months. 3. *La Rage Mue*, which is a Disease that lies in the blood. 4. The *Falling madness*, which Seizes on the Head, and is a sort of *Epilcpsie*. 5. The *Blasting* or *Withering*; this lies in the Bowels, which shrink up exceedingly. 6. The *Sleepy Disease*, which comes from little Worms in the Mouth of the Stomach, these Dogs die Sleeping. 7. The *Rheumatick Disease*, this Swells the Head very much, and makes the Eye Yellow. In these five later Diseases the Dogs will not Eat, (nor at any time when they are Sick,) but they Live eight or nine Days without Hurting any Body, and then die of Hunger.

The two first are Caught by the Breath of Dogs being together, as in the Plague among Men: the latter are likewise *Contagious*, but Curable.

CIV. The Fore-feet of a *Rat* resembleth those of the *Castor*; The Hair is also some Fine, some Course, as in that Animal; the *Tail Scaly*, with Hairs between every *Scale*, like the *Castor's*, which shews these two Animals to be something a-kin: and indeed the *Water-Rat* comes very near to the *Beaver*, and makes its Holes in the Bank sides of Ponds after the same manner.

Observations
on the Dis-
section of a
Rat; By Mr.
Rich. Waller.
n. 166. p. 594.

The *Penis* in the *Rat* has a particular Passage near the *Navel*, as in *Squir-* Fig. 247.
rels, and not at the *Anus*, as in the *Castor*.

The *Liver* is full of little *Specks*, as big as Pins heads; which are the little *Glands* thereof.

There was no *Gall Bladder*, but a *Ductus Felleus*, possibly the *Bladder* was inclosed in the *Parenchyma* of the *Liver*, as it is in some Animals.

The *Cacum* was much larger than the *Stomach*, and in shape like that of the *Castor*.

The *Testicles* lay not behind, but in the *Groins* on the *Os Pubis*. These were like a bottom or Skein of *Thread* Rumpled up together, which was Visible through the *Coats* of the *Testicle*. This *Thread* continued of near the same size in the *Epididymides*, only towards the *Deferentia* it grew larger.

It was tender, and not easie to be unravel'd; so that I could not draw-out above three *Quarters* of a *Tard*.

The *Prostrata* lay under the *Spermatick Artries*.

The *Kidneys* were *Whitish*, with their *Succenturiati*.

At the Neck of the *Bladder* were inserted the *Vesicula Seminales*; *Transparent* and filled with the *Semen*.

Toward the end of the *Penis*, which had a *Bony Gristle*, were two large *Glands* emptying themselves near the End of the *Penis*, and contained a Substance like *Cream*, as in the *Dormouse*; observed by *Swammerdam*.

A A. The *Kidneys*, a a. the *Renes Succenturiati*; bb. the *Ureters*; c c. the *Crural Veins* and *Arteries*; D. the *Arteria Magna*; e. the *Vena Cava*, F. the *Bladder*; gg. the *Spermatick Vessels*, *Veins* and *Arteries*; h h. the *Testes*, with the *Branches* of the *Veins* and *Arteries*; i i. the *Epididymides*; k k. the *Deferentia*; l. the *Penis*; m m. the *Vesicula seminales*; n n. two *Glands*, from whence a thick Juice might be pressed out; o. the *Balanus*.

Explicatione
of the Figure.

CV. 1. The *Sable-Mice* (which were first observed in *Lapland* about *Thorne* 1697) are near as big as a little *Squirrel*: their *Skin* streaked, and spotted *black* and *light-brown*; they have 2 *Teeth* above, and as many under, very sharp and pointed; their *Feet* like those of *Squirrels*, they are so *Fierce*, and *angry*, that if a stick be held out at them, they will bite it and hold it so fast that they may be swing'd about in the *Air*; they are fat and thick and without any *Tail*.

Sable Mice,
By Sir P. Y-
caut. n. 251.
p. 110.

In

In their March they keep a *Direct line*, generally from *North East* to *South West*, and are innumerable *Thousands* in each *Troop*, which for the most part is a *Square*: they March by *Night*, and in *Twilight*, and lie Still by *Day*. The distance of the *Lines* they go in is of some *Ells*, and *Parell* to each other. If they meet any thing that might stop them, they avoid it not, tho' it were a *Fire*, a deep *Well*, a *Torrent*, *Lake*, or *Morass*, but without any *Hesitation* Venture through, and by that means many *Thousands* of them are destroyed. If they be met *Swimming* over *Lakes*, and be forced out of their *Course*, they presently *Return* into it again; when they are met in *Woods* or *Fields* and stop, they set themselves upon their hinder *Feet* like a *Dog*, and make a kind of *Barking* or *Squeeking* *Noise*, leaping up as high as a *Man's Knee*, defending their *Line* as long as they can: and, if at last they be forced out of it, they *Creep* into *Holes*, and set up a *Cry* founding like *Biabb, Biabb*. They never come into any *House*, nor meddle with any thing that is *Man's Meat*; if a *House* happen to be in their *Way*, there they stop till they *Die*, but through a *Stack of Hay* or *Corn* they will *Eat* their *Way*; when they March through a *Meadow*, they endamage it much, by *Eating* the *Roots* of *Grass*, but if they *Encamp* there by *Day*, they quite spoil it, and make it look as if it were burnt, or strewed with *Ashes*. The *Roots* of *Grass*, with *Rotten Wood*, and the *Insects* in it, are their *Chief*, if not only *Food*.

These *Creatures* are very *Fruitful*, yet their *Breeding* does not hinder their *March*, for some of them have been observed to carry one *Young One* in their *Mouth*, and another on their *Back*.

It is reported that some *Poor Laplanders* have *Eat* several of them, and found their *Flesh* to *Taste* like *Squirrels*: *Dogs* and *Cats* *Eat* only the *Heads*, and *Birds of Prey* only the *Heart*. During the *Winter* they lie under the *Snow*, and have their *Breathing Holes* upon the top of it, as *Hares* and other *Creatures* use to have, The *Country People* are very glad of those *Guests*, foretelling there will follow great *Plenty* of *Game*, as of *Fowls* *Squirrels*, *Lo-Cats*, *Foxes*, &c. where of late *Years* there has been great *Scarcity*, being told by some old *People* that these sort of *Creatures* were seen in *Lapland*. about 20 or 30 *Years* before, and that thereupon they had *Abundance* of such *Game*.

By
ib. p. 112.

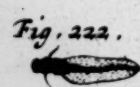
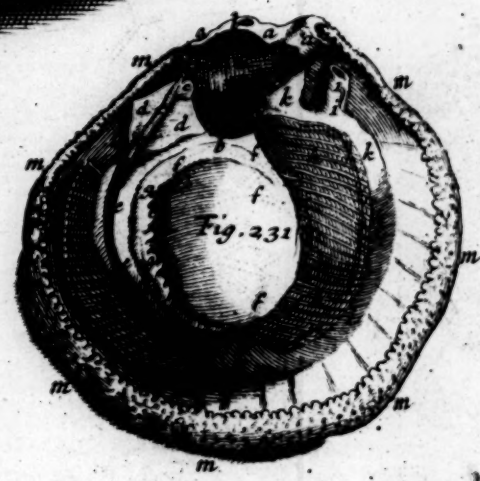
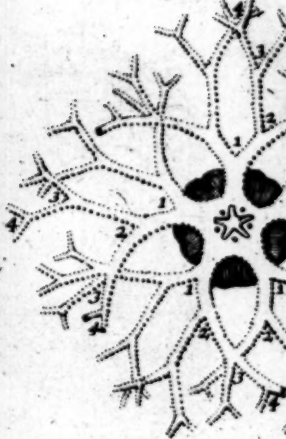
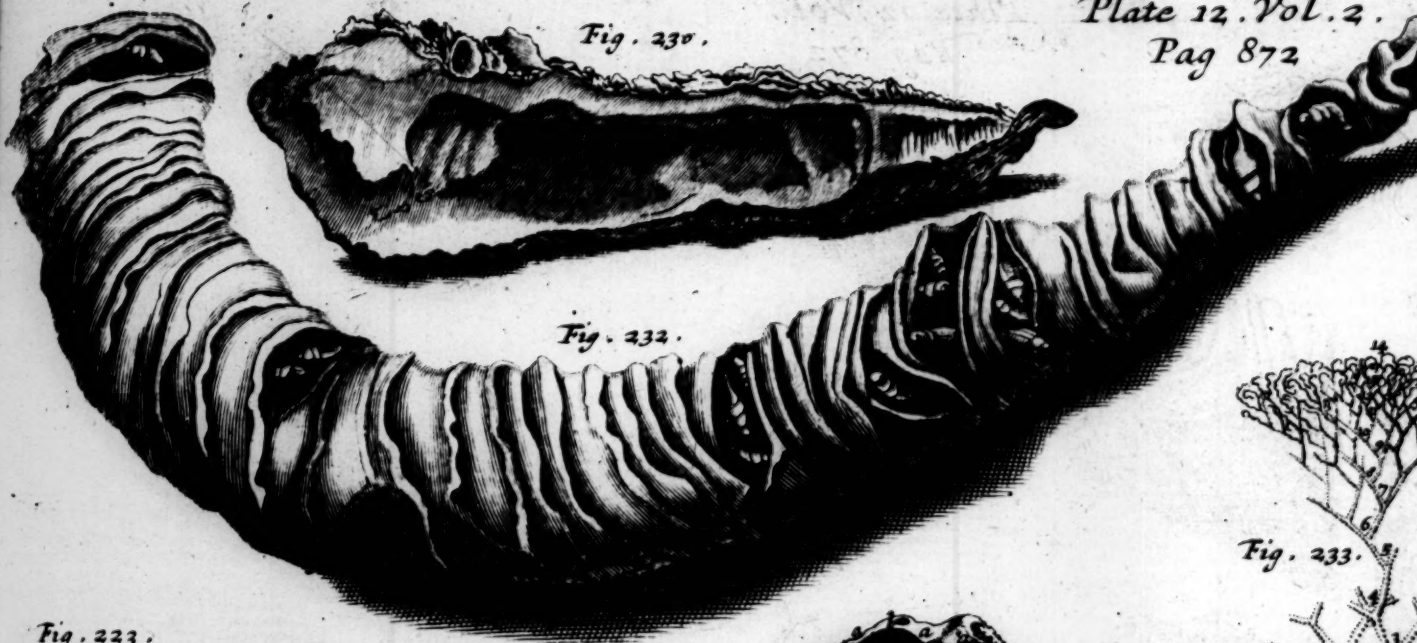
2. These *Mice* are the same with those called *Mures Norwegici*, described by *Olaus Wormius* in his *Musæum*.

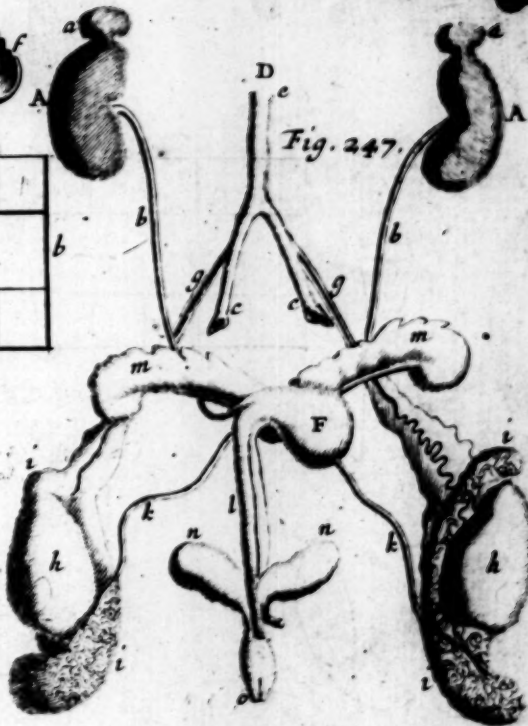
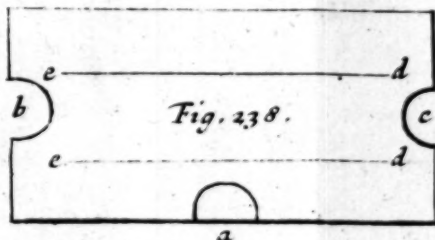
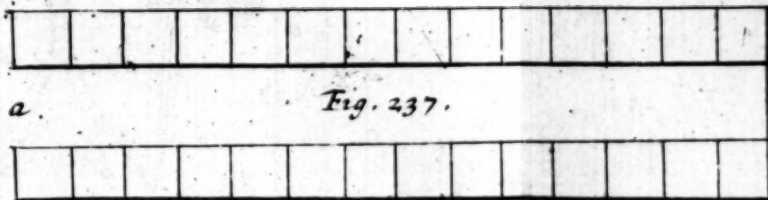
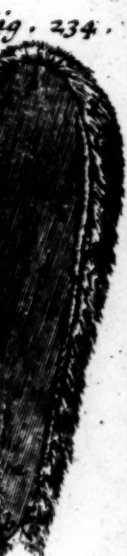
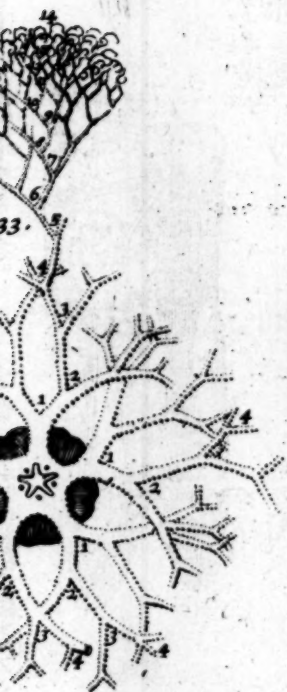
The Russian
Way of curing
Castoreum; By...
n. 163. p. 501.

CVI. Take *Bever Stones*, and get the *Milk* out of them as clean as you can, then set upon the *Fire* a *Skillet* or *Kettle* with *Water* big enough to contain the quantity of *Stones* you have to *Cure*: let the *Water* *Boil*, and put into it half a *Shovel-full* of *Clean Wood Ashes*, then tie the *Stones* together in *Couples*, and put them into the *Water*, and let them boil therein for half a quarter of an *Hour*, then take some *Birch Bark*, and lay it on the *Fire*, and let the *Stones* be well *Smoaked* over it for the space of an *Hour* untill they are well dried in the *Smoak*, then hang them up in a *Kitchen*, or in the *Air*, for a *Week* or more, untill they are perfectly *dry* and *hard*, after which they may be packed up in a *Cask*, or otherwise for *Transportation*.

CVII. Take

[illegible]





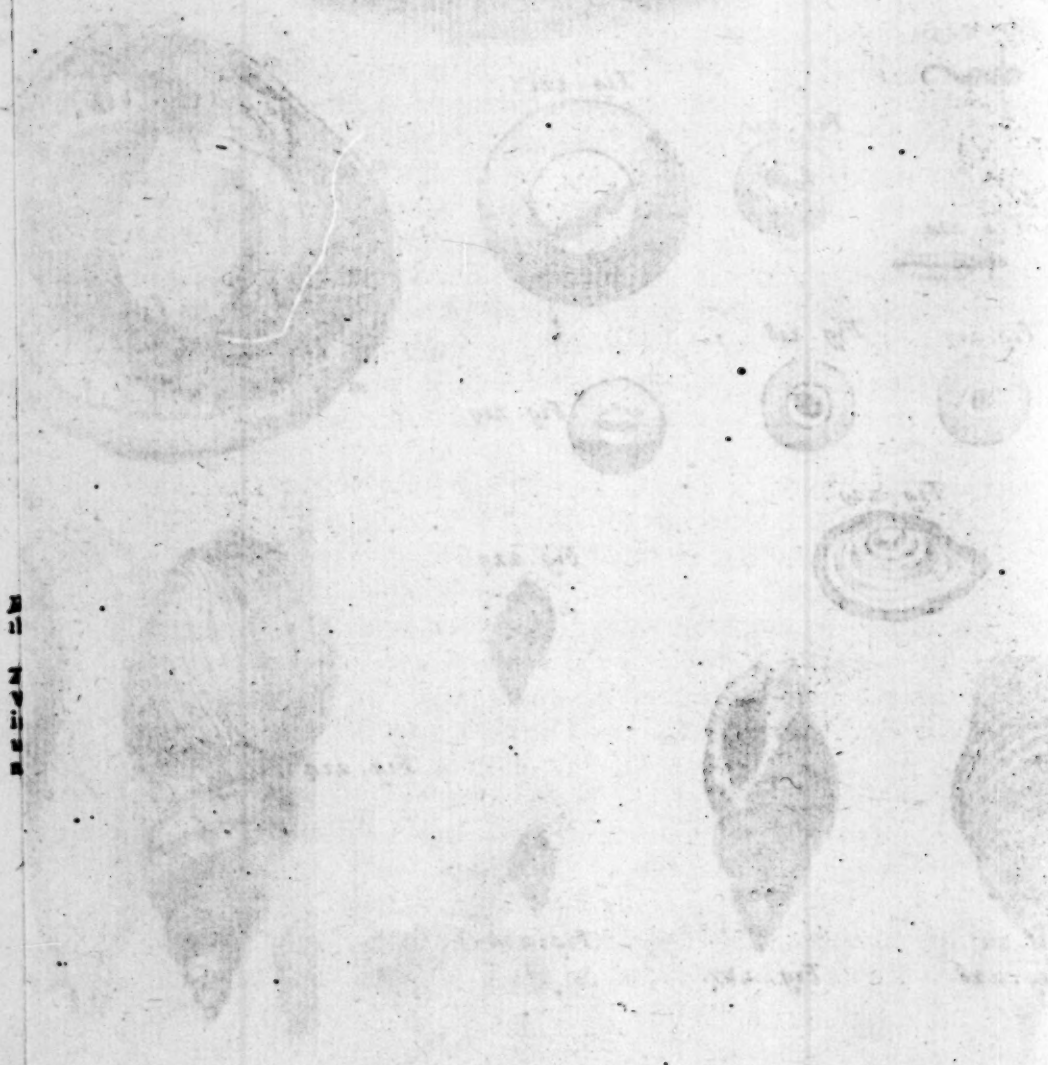


PLATE 1

CVII. That the *Testicles* of the Animal in *New England* call'd *Musk-quash*, do smell strong of *Musk* (as Mr. *Joffelin* saith,) is most certain : For, I have known some of them kept a long Time in ones Pocket, till they were become hard and black, and yet Smelt as strongly as at first, which in my Opinion was nothing inferiour to the Scent of that which is commonly sold for *Musk* in the Shops. I remember, that one of our Seamen, being laid to Sleep too near the Fire place, with one of these dried *Testicles* in his Pocket, it happened that a Coal burned through his Breeches to it, and made so great a Scent of *Musk*, that he might easily have been smelt a good way off.

This Animal deserves to be further enquired into, especially if what M. *Thevenot* relates be true; viz. That *Musk* is nothing else but the *Testicles* of a Beast ilke a *Deer*, found in *China*, in the Province of *Honan*.

CVIII. The whole Shape of this Animal (which by some Authors is called *Tajacu*) was such, that we may easily reduce it to the Swine-kind, as plainly appears by the Figure: but it was much less than our usual *Hogs*; for from the End of the Body, where the *Tail* should be, to the top of the Head between the Ears, were 2 Foot and 2 Inches, from thence to the end of the *Nose* 11 Inches. The Girth of the Body 2 Foot; the Girth of the Neck 16 Inches; of the Head, in the largest place, 18 Inches; and of the Snout 12 Inches: For the lower Jaw in this *Mexico-Hog* was more Protuberant, and the Head less tapering than in our *swine*, and in the *Skeleton* appears much like that of the *Baby Roussa*, only it had not those *Teeth*; and the *Neck* appeared so very short and thick, not from those large *Glands*, which in some of the *Swine kind* do so stuff out their *Necks*, but from the short turning upwards of the *Vertebra* of the *Neck*, which were kept so close to the Body, by the Insertion of that strong *Ligament* into the Poll from the *Back*, which in Animals that are *Prono Capite*, is of extraordinary Use; and much adds to the Strength of this Animal. The Colour of the Body was *Grisly*; being beset with *Bristles*, which were thicker than those of a *Hog*, and lesser than those of a *Hedge Hog*; but like those of a *Hedge Hog* or the *Quills* of a *Porcupine*, they were Variegated with *white* and *black* Rings. The *Belly* was almost bare. The *Bristles* on the Sides were shorter, and gradually increased in length, as they approach'd the Ridge of the *Back*; where some were 5 Inches long. Between the Ears, on the Head, was a large *Tuft* of these *Bristles*; which were for the most part *Black*. The Ears were about 2½ Inches long, and pricking up; the Eyes (as they are usually in *Pigs*) but small; for the lower *Canthus* to the End of the *Nose*, 6 Inches; the *Nose* like that of a *Hog*, the Mouth not large, the side of the lower Lip made smooth, as it were by the Rubbing of a *Tusk* in the upper Jaw; the Feet and Claws perfectly as in common *Hogs*, only the upper Claws on the same Foot proportionably longer, being one Inch and a Quarter long, whereas the *True-Claws* were scarce one Inch and an Half, It had no *Tail*. But

The Musk-quash; By...
n. 127. p. 653.

New England's Rarities.

The Anatomy of a Mexican Musk Hog, By Dr. Edw. Tyson, n. 153. p. 359.

Fig. 248.

Fig. 250.

what is most particular, and Differences it from any other Animal I know of in the World, is the Feet, or Navel, or Foramen rather, on the hinder part of the Back.

Hist. Anim.
Mexican.

These Animals are bred in *New-Spain*, *Nicaragua*, *Terra Firma*, and *Brafile*: They are usually met with in the Mountains and Woods, and go in *Herds* together. They Feed on *Roots*, *Acorns*, and *Fruits*: but, as the greatest Delicacy, they Hunt for all manner of *Poysonous Serpents*, and *Toads*; and having caught them, holding them with their Fore-Feet, with a great deal of Dexterity, with their *Teeth* they strip off their Skin from the Head to the Tail, then greedily Devour them. *Poslea* (saith *Jo. Faber*, who had the Account from *F. Gregorius*, who often has seen them, and lived in those Parts 24 Years) *Radice seu certa Arboris Corticem sibi notum quarit, quem comedit, ne Veneno inficiatur; & hac ratione optime Nutritur. Crescit & Augescit.* When they are made tame, they will feed on any thing; but naturally they are very Fierce.

Ovideus Remarks that the *Swine*, which the *Spaniards* left on the Islands of *St. Domingo*, *St. Joannes*, and *Jamaica*, Multiplied and Encreased; but those in *Terta Firma* durst never go in the Woods, but were destroyed by the *Lions*, *Tigers*, and *Lupi Cervarii*: Yet in these Woods there are great Herds of these *Tajacu's* that can make their Party good with the Fiercest of them. If any be Wounded, presently he gets to his Assistance a great Number of his Kind, and never leaves till he has Revenged the Injury, or is Slain. They are always at Enmity with the *Tygers*; and there is often found the Body of a *Tyger* and abundance of these *Tajacu's* Slain together. If they spy a Man, they will fiercely set on him, and his best Escape is to get up a *Tree*, which they will most furiously assault with their *Teeth*; nor will easily leave him, till forced by *Hunger*, or Slain by him, by *Club*, *Darts*, or a *Gun*. If they hunt them, their *Dogs* are often torn in pieces by them. Their Flesh is Esteemed very good, and much desired by the Inhabitants. They have but a very little Fat. Our Subject had scarce any.

Fig. 253.

We come now to the *Anatomy*; having therefore divided the *Muscles* of the *Belly*, we took notice of the Remarkable Structures of the *Stomachs*; for it had three. Into the middlemost was inserted the *Oesophagus*, or *Gullet*; which we therefore shall call the *First Ventricle*, or *Stomach*. From this, on one side was a large Passage into the Second, which Pouching out had its two Ends winding like a *Horn*, and on the other side of the First or Middle-Stomach was a free open Passage into the third, which Emptied it self into the *Duodenum*.

Fig. 254.

The First Stomach was lined within, with a white thick hard *Membrane*; almost like the inward Pellicle of the *Gizzard* of *Fowls*; with which none of the other *Stomachs* were endowed. For the Inward Surface of the Second was smooth and soft, its *Membranes* thin, and more inclining to the Common make of that of *Carnivorous Animals*: The third somewhat like this, but thicker and rimpled within, with large *Plicae* or *Folds*. *Dr. Grew* takes Notice that in the *Common-Hog*, against the *Pylorus*, stands a round *Caruncle*, as big as a small *Filberd Kernel*, like a stopple to the *Pylorus*, for Preventing

Sto. and Guts
of Quadrup.
6. 3.

(as

(as he conjectures) a too Sudden and Copious Irruption of the *Aliment*. This is sufficiently Provided for in our Subject, by the great streightning of the *Pylorus* here, and the great Ascent it must take, before it can go out; which may be the Reason too of Natures making these several Cells, or Partitions, for the better *Digestion* and *Maceration* of the *Food*; for, it being *Frugivorous*, *Graminivorous*, and *Carnivorous* too, the *Stomachs* are so contrived, that as the First here by its *Inward Pellicle* somewhat resembles that of *Birds* that are *Carpophagous*, so the others those of *Quadrupeds*. Fig. 252.

The *Small Guts*, which in other Animals, being fastned to a large *Mesentery*, usually do hang down, were here Closer gathered, by the shortness of this *Membrane*, to the *Spine*: and the *Colon*, which in others is suspended, here by its Peculiar structure lies Loose, and falls down; for the *Duodenum*, arising from the *Pylorus* with a short turn, and the other *Small Intestines*, made abundance of *Convolution*s and Windings. And altho' the *Mesentery* was but very short from the *Spine*, and its Circumference seemingly but very little; yet in this Compass it contained 27 Foot of these *Intestines*; for so much they measured from the *Pylorus* to the *Colon*. The *Colon* was not fastened to the *Periphery* or *Rim* of the *Mesentery*, as ordinarily: but arising from the *Centre* or middle, made a *Spiral Line*, its End hanging loose, and its turnings closely united one to another by *Membranes*. This *Colon* was very large, in respect of the other *Guts*; and, as I measured it, it was 9 Foot long. It had a short *Cæcum*, but pretty Wide, and fill'd with *Fæces*. What Dr. *Grew* observes, that 'tis peculiar to the *Cæcum* of a *Hog*, and that of a *Horse*, to have the same Structure with the *Colon*, is true here too: And it may be reckoned as an *Appendix* of the *Colon*. The *Mesaraick Vessels* were also extraordinary; for here we observed a large *Vein* and *Artery*, running a small and equal Distance from the *Intestines*, and from them arising an infinite Number of lesser, but Straight *Vessels*, which going Regularly to the *Guts*, and in great Numbers, afforded a very pleasant Prospect.

The *Spleen* was about 10 Inches long almost, almost of the same breadth throughout, and in the middle was one Inch and half broad; it was of a Lead-Colour, a little Speckled or Marbled. The *Liver* consisted of 4 large *Lobes*, and was of a dark red Colour; it appeared plainly *Glandulous*; and had no *Vesica fellea*, but it had a *Ductus Biliaris*, which went from the *Liver* to the *Duodenum* as usually. The *Pancreas* was about 5 or 6 Inches long; and was made up of several *Glands*.

The *Testes* were two Inches long, larger at the upper end than the lower, and in the middle about an Inch broad; they were placed in the *Scrotum*. Their Colour White, their Structure close, so that the *Vessels*, which composed them, did not so plainly appear as in an Ordinary *Boar*. Notwithstanding which no doubt their whole Compages was *Vascular*, tho' here closer wrought together, and united. Their Use is to Prepare the *Semen*; which is conveyed thence by the *Vasa Deferentia* to the *Vesicula Seminales*.

These *Deferentia* arise near the lower part of the *Testes*; and are so Inserted, that they might also equally empty themselves either into the *Vesicæ Seminales*, or *Urethra*. The *Vesiculæ Seminales* were 1st Inch long, in some places $\frac{1}{4}$; in others half an Inch broad.

Tho' call'd *Vesicula*, yet here they appeared more *Glandulous*, nor was their *Cavity* any thing considerably large. The common Orifices to them, and the *Vasa Deferentia*, made a rising in the Inside of the *Urethra*; which *de Gaaf* calls *Caput Gallinaginis*.

In other Animals at this place is seated that *Glandulous* Body, called the *Prostata*: But the *Vesiculæ* here being so *Glandulous*, possibly they may perform their Office; unless we should ascribe their use to those two *Glands* which lay on each side the *Urethra*, and emptied themselves, with two Orifices, near the Root of the *Penis*. These *Glands* were *Cylindrical* of a Whitiish Yellow Colour, an Inch and half long, and $\frac{1}{4}$ of an Inch in Diameter. Their Substance close, like that of the *Testes*, and no perceptible *Cavity* within, and they lay along the outside the *Urethra*, reaching from the *Musculi Erectores Penis*, to the *Glandulous Vesiculæ* before described. The *Vesiculæ Seminales* being *Glandulous* must therefore secrete some Juice, which in all likelihood is some ways serviceable, tho' not Principally, in *Generation*. The *Penis* was a long slender Body, made up of several *Muscles*, whereof two were very long. The *Vesica Urnaria* or *Bladder*, of *Urine*, was rounder than in some other Animals, where usually 'tis more Oblong. The *Ureters* were inserted at the Neck of the Bladder, not Sides, as in some.

In the *Thorax* we were surpris'd at the strange Formation of the *Arteria Aorta*, which as it descends along the *Spine* in all other Animals, I have observed its *Trunk* is almost of an equal bigness, only a little tapering downwards: But here, between the Heart and its Branchings into the *Iliac Arteries*, we found 3 large Swellings out. The largest was that nearest the Heart, which after a small straightning again emptied it self into the Second; which, though something less than the First, yet was much larger than the Third, which was near the Division of the *Aorta* into the *Rami Iliaci*. Two of these Swellings I opened, and found within several unequal Cells, or Hollows, but withal could not perceive but the *Membranes* here were altogether as thick, as where the *Artery* was nothing extended. But, this being the only one of the Kind I have dissected, I know not how far it may be *Preternatural*.

The Aperture of the Eye was but small, as in the *Hog kind*; the *Membrana Nictitans*, Plainer than usually in *Quadrupeds*, which might be convenient, since, wallowing in Mud, they might the better rub off any Filth that might happen there; the *Muscles* not so distinct, as in some Brutes, and hence the Motion of their Eyes not so Quick nor Regular, the *Pupil* round, the *Optick Nerve* inserted almost in the Axis of the Eye, and on the inside made a small Dint, the *Choroides* of a Pale Violet, and brownish-Colour.

Just on the Ridge on the Back, over the hinder Legs, is seated a *Glandulous*

ious Body, which all Authors call the *Navel*. It is so covered by the long *Bristles* there, that it was not to be observed, but by opening of them with the Hand: And then you shall find a small Space there almost bare; only beset with fewer, shorter and finer Hairs; and in the Middle of it, the protuberant Orifice of the *Gland*, by which it discharges it self of the Liquor, which is separated by it within. This Orifice, or Foramen, had its Lips a little Reflected and Protuberant, above the Surface of the Skin. It would easily admit of a large Probe, which I could turn into several Parts of the *Gland*. Upon a gentle Pressure with my Finger, I could observe a small Quantity of a white yellowish Juice, and some part of it of a little darker Colour; which yielded a very pleasant and agreeable Scent, and was judged by my self, and several others who smelt it, to be much like that of *Musk* or *Civet*. The *Gland* it self was seated between Fig. 251. the Skin, and some Part of the *Panniculus carnosus*: For in the Middle of that Part or Surface, which respected the Back, 'twas bare, and not cover'd with that *Muscle*, but only the Edges of it enclosed within it; so that in taking off the Skin, the *Gland* too, as I have observed, could not easily escape, but go with it. However, this *Muscle* may be assisting to it, by its Contractions, in pressing out of its Liquor, as the *Sphincter Muscle* is to those *Scent Bags*, placed at the Extream of the *Rectum* of other Animals. This *Gland* was conglomerated, or made up of several minute and small white *Glandules*; it had no considerable *Cystis*, or Cavity within; but like the *Pancreas* or *Salivatory Glands*, it had abundance of *Secretory Ductus's*, which terminating at last in one, discharged its separated Juice by a common Orifice.

This Orifice, having something of a Resemblance of a *Navel*, has imposed almost upon all who have writ of this Animal, (and have only superficially viewed this Part, without examining any thing further,) to believe it an *Umbilicus*, and those who have deviated from this Sentiment, have been as unhappy, in delivering altogether as absurd, and extravagant Conjectures about it.

But there is nothing I can parallel this *Gland* with, more than those scent Bags, or *Scent Glands*, I have formerly mentioned to be in other Animals. This I first took notice of in *Polecats*, in which, just at the Extream of the *Rectum*, were placed 2 *Bags* fill'd with a crassie and whitish Liquor, whose Stink was so very great, that I could nor well endure the Room, till I had removed them, and then the whole Body seem'd very inoffensive. The same I have observed in abundance of other Animals; as in all the *Polecat kind*, in our common *Cats*; in a *Lyon*; in *Dogs*; in a *Fox*, &c. Those Bags in the *Civet Cat*, or *Hyana Odorifera*, are nothing but the same; as are likewise those of a *Muskquash* mentioned above: For they are not the *Testi-* vid. sup. cles of that Animal, for having seen the Skins here in Town, and those *Musk-* §. CVII. cods, I find them to be only these *Scent bags*. So the *Castoreum* we have in our Shops is not the Stones of a *Bever*, as formerly reputed, but of the same Nature altogether with our *Scent Bags*. vid. sup. §. CVI.

And

And indeed in most Species of *Animals* there may be observed something the same, or analogous to it, which gives them their peculiar *Fætors*, or *Smells*. Thus I have observed in *Reptiles*, as in the *Rattle-Snake*, in *Vipers*, in our common *Snake*, &c. two long Bags in the *Tail*, which empty their fœtid Liquor, near the Verge of the *Rectum*. But in all *Animals*, I find not these Bags or Glands seated here, but in some, in different parts of the Body: In *Fowl* and *Birds*, in the *Rumps* you will meet with two Glands, which have 3 *Pipes*, or *Secretory Ductus*, arising on the Top of it, above the Surface of the *Skin*, which discharges a fœtid Liquor. I find these *Glands* the largest in *Geese* and *Duck Kind*, which use the *Water*; and any one at the Table, by tasting, may perceive in a *Duck* how strong scented they be. In *Turkeys* 'tis less glandulous, but they have a larger *Cystis* within. In the *Ostridge* indeed, I did not observe it on the *Rump*, but something higher on the *Back*, where it made two Bunchings out, and under the *Skin* I found a *Cystis* fill'd with a concreted yellowish Juice. This something approached near the place where was seated the *Gland* in our *Mexico-bog*, which I call the *Scent-Gland*, and it yielding so grateful a *Perfume*, (for so it was esteemed by my self, and several others who smelt it) from it, I have named it, the *Mexico Musk-bog*. But this is remarkable, that as our *Musk-bog* has its *Scent Gland* seated on the *Back*, so the *Gazella*, or *Musk-Deer*, has his *Musk-bag* on the *Belly*, near the *Umbilicus*. Every one observes what an horrid Stink the *Urine* of *Cats* will make where it lights; perhaps in rendring their *Urine*, at the same time they may empty their *Scent bags* seated at the *Rectum*, which mixing with it, in a great Measure, may give it its strong *Fætor*. So the same of *Rats*, of *Mice*, of a *Fox* when hunted, &c.

No Author indeed has called the *Scent* of this *Animal* a *Perfume*; On the contrary, they have all branded it as a *Stink*: But even the Best *Perfumes* sometimes make the greatest *Stinks*. *Civet*, nay *Musk* it self, when fresh and green, and in large Quantities, are no ways agreeable, but very offensive to the *Smell*, as many have observed: And what is more too, such as *Ambergrease* at the first, as *Gull. Piso* Assures us.

Our *Tajacu* therefore, when young, and when but a small Quantity of this Liquor is separated by this *Gland*, may afford but little or no *Scent*; and *Foxes*, till they are well Grown, do not much stink; but afterwards, when in great Plenty, this Juice is voided, by its Copiousness, and being thin and fluid, and so more Vapourable, it may strike our *Organs* with such brisk and nimble Strokes, as to Create a *Pain*; whereas a more leisurely Appulse of its Particles from a lesser, and concreted Body, may give a *Pleasure*. So our *Tajacu*, when this *Gland* does very liberally discharge its Liquor, may be thought to stink; and yet this *Stink* in Time may become a *Perfume*. Thus that fœtid Liquor in the *Scent-bags* of a *Weefil*, having formerly put it on a *Paper*, and kept

kept it a little while, afforded me a pleasant Smell. Why therefore we perceived no Stink at first, upon the Dissection of this *Gland*, but rather a sweet and pleasant Smell, (if it is otherwise in the Countries, where they breed,) this may be the Reason, because it had been dead some Days, before I examined this Part, and then I found but a small Quantity of an incrassated Liquor there; tho' I must acknowledge, that I was informed, that when it was alive, it was observed by the Family where 'twas kept, that wherever it went it left a good Perfume behind it. This I am sure of that when 'twas dead, and observed by me, and several others, it yielded a fragrant one; which I think is sufficient to justify, or at least to excuse the Name I have given it.

We further observed, that the *Cranium* seem'd entire, without *Sutures*: From the Nose to the End of the Pole, $8\frac{1}{2}$ Inches. Here the *Cranium* grew very narrow, and then did spread it self again *Triangularwise*, and behind made a large *Hollow* where it respected the Back, and where were inserted strong *Muscles*, and the *Ligament* from the Back, I formerly mentioned, by which Means the Head is so kept straight up, that when Alive he seem'd to have but a very short, if any Neck at all. The *Forus Auditorius*, or Passage to the Ear, was something Remarkable; being placed near the Pole. In the upper Jaw before were four Teeth, or *Incisores*, a little further, was placed a large flat Tusk, sharp Edged, and standing outwards; and beyond that, of each Side, six Double Teeth, or *Molares*. The lower Jaw was $6\frac{1}{2}$ Inches long, $1\frac{1}{2}$ broad at the first double Tooth, of which there were 6 of each Side. The Bone of the lower Jaw here, from the *Dentes Molares* to the *Incisores*, seem'd spongy and curious; and the Tusks in this Jaw were Rotted out; as were one or two of the *Incisores*, which in all were about four.

There were 7 *Vertebrae* of the Neck, which measured in Length $4\frac{1}{2}$ Inches; The first or *Atlas*, had two broad transverse Processes, but no Spine; The second had a broad large Spine, the 3d, 4th, 5th, had no Spines, the 6th, and 7th, had large Acute ones. There were 19 *Vertebrae* of the Back; the Spines of the first, 2d. and 3d, were about 2 Inches long, but they gradually Decreased, as they Approched the Tail. The first *Vertebra* of the *Os Coccygis*, was 2 Inches long, but I thought, that at first it might have been several, though now it was but one Bone. There were about 6 *Vertebrae* more, which ran no farther than the Extent of the *Os Ischii*. There were 14 Ribs of each Side; the *Os Sterni* jutting out about an Inch beyond the Setting on of the first Ribs. Fig. 149.

The *Scapula* was 5 Inches long, the *Os Femoris* of the Fore-foot, $5\frac{1}{2}$ Inches long; the *Os Tibia* of the Fore foot, about the same Length in the whole; but from the Juncture with the *Os Femoris* to the *Os Metatarsi*, was but 4 Inches, for from the Juncture with the Thigh bone, it jutting out farther, as in the Figure. The Bones of the *Tarsus* were 5, of the *Metatarsus* 3, about 2 Inches long; the Bones of the *Digiti* 9, there being 3 to each Claw, and 3 Claws to each Fore-foot. The *Os Femoris* of the hinder Foot, was almost 6 Inches long; and near its Juncture with the *Os Tibia* it had a small Bone, like

like the *Patella* in the *Knee* of a Man. In the Leg here were two Bones; the *Fossile Majus* and *Minus*, 5 Inches and a half long: But this Part in the Fore-Leg was only a single Bone, though in a Dog, a Monkey, and some other Animals, there are two Bones in the Fore Leg likewise, The *Os Calcis* was almost two Inches long; and there were four other Bones of the *Tarsus* or *Instep*. The *Metatarsus*, or *Foot*, was composed of 4 Bones; and the two innermost much the largest, being $2\frac{1}{4}$ long; there were 4 *Digiti*, and in each 3 Bones, whereof the last was covered with a Nail.

Explication
of the Fi-
gures.

Fig. 248.

Fig. 249.

Fig. 248. Represents the natural Shape of this *Mexico-hog*, and the Line *a*, points to the *Scent Gland*.

Fig. 249. The *Skeleton*, *a*. the *Fore Teeth*, *b*. the *Tusk*, *c c*. the *Grinders*, or *Molars* *d*. the *Lower Jaw*, *e*. that Part of the Lower Jaw which was *Carious*, *f*. the *Cranium*, *g*. the Orbit of the Eye, *h*. the *Porus Auditorius*, or Passage to the Ear, *i*. the *Triangular Expansion* of the *Cranium* backwards, *k*. the *Vertebra* of the Neck, *ll*. the *Vertebra* of the Back and Loyns, *m*. the *Vertebra* of the *Os Coccygis*, *nn*. the *Ribs*, *o*. the *Protuberant Bone* of the *Sternum*, *p*. the *Scapula*, or *Shoulder Blade*, *q*. the *Os Ischii*, *rr*. the *Os Femoris*, or *Thigh bones*, *s*. the *Patella* of the hinder Legs, *t*. the *Tibia* of the Fore Leg, *v*. a large *Protuberance* of the *Tibia*, *w*. the *Tibia*, or *Fossile majus* of the Hinder Leg, *x*. the *Fibula* or *Fossile minus* of the Hinder Leg, *yy*. the *Tarsus* or *Instep*, on both Legs, *z*. the *Calx* or *Heel*, in the Hinder Leg, *a a a*. the Bones of the *Metatarsus*, or *Foot*, *β β β*. The *Digiti* or *Toes*, *γ γ γ*. the *Nails*.

Fig. 250. Fig. 250. The Orifice of the *Scent Gland*, as it naturally appeared on the Outside of the Skin of the Back: A little Space round this Orifice was almost bare of Bristles.

Fig. 251. Fig. 251. The *Scent Gland* it self, which was conglomerated.

Fig. 252. Most of the *Viscera*; *a*. the *Oesophagus*, or Gullet, *b*. the First Ventricle or Stomach, *c*. the 2d Ventricle or Stomach, *d d*. the *Cornua* or Horns of the 2d Stomach, *e*. the 3d Stomach, *f*. the *Pylorus*, *ggg*. the *Intestina Tenuia*, or small Guts, *h h h*. the *Colon*, *i*. the *Cæcum*, *k*. the *Rectum*, *l*. the *Mesentery*, *m m*. the *Mesaraick Vessels*, *n*. the *Pancreas*, *o*. the *Spleen*, *p*. the *Liver*, *q*. the *Ductus* of the *Gall*, from the Liver to the *Duodenum*.

Fig. 253. Fig. 253. The Outside of the 3 Stomachs, more in their natural Situation; *a*. the *Gula*, *b*. the first Stomach, *c*. the 2d Stomach, *d*. the 3d Stomach, *e*. the *Pylorus*. *f f f*. the *Blood Vessels*.

Fig. 254. Fig. 254. The *Stomach* opened; *a* the *Oesophagus*, or *Gula* *b*, the Entrance of the *Gula*, or Gullet into the first Stomach, *c c*. the Inside of the first Stomach, which was invested with a strong, thick, white, Pellicle or Membrane, *d d*. the 2d Stomach, *e e*. the 3d Stomach, in which were remarkable several *Plicæ* or Folds. *f*. the *Pylorus*.

Fig. 255. Fig. 255. The *Genital Parts* and the *Bladder*: *a*. the *Bladder* of Urine; *b*, the *Neck* of the *Bladder*, *c c*. the *Ureters*, *d d*. the *Testes*, or *Stones*. *ee*. the *Vasa Deferentia*. *f f*. the *Vesicula Seminales*, which here were Glandulous. *g*. the

the *Caput Gallinaginis*, where the *Vesicula seminales*, and *Vasa Deferentia* empty themselves into the *Urethra*. *b b*. two Glandulous Bodies, which possibly may be reckoned the *Prostata*. *i*. the Orifices, by which these glandulous Bodies empty themselves into the *Urethra*. *k*. the *Urethra* opened. *l*. the *Penis*. *m m*. two Muscles belonging to the *Penis*. *n n*. other Muscles assisting to the same.

Fig. 256. The Heart, and the *Aneurismata* of the *Arteria Aorta*, or great *Fig. 256.*
Artery; *a* the Heart, *b b* the Ascending Branches of the great *Artery*, *c*. the descending Trunk of the great *Artery*, *d*. the first *Aneurisma* or Distention, of the great *Artery* open, to shew its several Cells within, *e*. a straightning of the *Artery* again, *f*. the 2d *Aneurisma* opened likewise. *g*. the 3d or smallest *Aneurisma*, *b b b*. the *Iliac Branches* of the great *Artery*.

CIX. This Animal, which was brought alive from *Virginia*, has many Names given it by different Authors and generally by the *English* it is called *Opossum*, or *Possum*. In *Latin* it is named *Simi Vulpa*, and *Vulpi-Simia*, as if it were of a middle Nature, between a *Fox* and an *Ape*. But I think a Denomination might be best given it, from that particular wherein 'tis most distinguishable from all other Animals; which is that remarkable Pouch, or *Marsupium* it has in the Belly, into which, upon any occasion of Danger, it can receive its young; whence it may properly be named, *Marsupiale Americanum*: And I am apt to think it may be reduced to the Vermin Kind.

The Anatomy of an *Opossum*, by Dr. F. Tyson, n. 239. p. 105. Fig. 257.

It measured from the Extremity of the *Nose* to the Tip of the *Tail*, 31 *Inches*, the length of the *Head* was 6 *Inches*, the *Tail* was one Foot long, the *Neck* and the *Body* was the Complement of the first Dimension, the Girth of the *Body* now dead, was 15½ *Inches*; when alive and well, it seemed much thicker. The *Fore Legs* were 6 *Inches* long, the *Hinder Legs* but 4½ *Inches*. The Girth of the *Tail*, near the *Root*, was 3 *Inches* near the *Tip* but one *Inch*. The *Head* about the *Ears* was largest, measuring on the *Fore-head*, from one *Ear* to the other, 3 *Inches*; thence gradually tapering towards the *Nose*, and more resembling that of a *Pig* than a *Fox*. The Apertures of the *Eye lids* were not *Horizontal*, but lying in a straight Line from the *Ears* to the *Nose*, and not large. The *Ears* were about an *Inch* and an half long, not sharp, but of a roundish Figure. The *Ridus* of her Mouth, from the corner, on one side, to the end of the *Nose*, measured 2½ *Inches*.

The *Fore feet* had 5 long *Claws* or *Fingers*, equally ranging with one another, and a hooked *Nail* at the End of each *Finger*. The *Hinder feet* had 4 *Fingers* armed with hooked *Nails*, and a perfect *Thumb*, set off at a Distance from the Range of the other *Fingers*, and as in a *human Body*, this *Thumb* was shorter than the other *Fingers*, and had not a hooked or curved prominent *Nail*, but a tender flat one. This Contrivance of the *Legs*, *Feet*, and *Nails*, seems very advantageous to this *Animal* in climbing up *Trees* (which it does very nimbly) for preying upon *Birds*, which it is most fond of, tho' it eats other things too. These *Fingers*, *Toes*, or *Claws* were naked, without *Hair*, the *Skin* looking of a reddish Colour here.

They were about an *Inch* long, and the Thumbs almost as long. The Palms of all, especially if dilated, as it does in climbing, were large, but so contrived, as to be able to be contracted, as in Walking. but, that they might here be better secured from *Injury*, I find at the setting on of each Toe, in the Palms, a protuberant, fleshy and almost cartilaginous Body: In Feeding it self, it makes use of the Fore-feet in bringing the Food to its Mouth; as do the *Monkey* and *Squirrel-kind*. The Tail was without Hair, (only for a little way near the setting on) and tapering from the Root towards the Tip was covered with a Regular Order of small whitish Scales; which for the most Part were oblongish Hexagons, between each of which one might observe a little Skin or Membrane, in which they are fixed. The Colour of these Scales makes the Tail to appear Whitish, tho' the Skin seems of a darker Colour.

The Ears were also bare, and without Hair; And, although soft and slender, and in Colour and Substance almost resembling the Membrane of a Bat's Wing, yet they were erect and of an oval Figure. I could not perceive that cartilaginous Body, which usually is to be met with in the Structure of this Part, so that, if it did at all enjoy a Cartilage, 'twas at least much finer than in most other Animals. The Concha or Passage to the *Forus Auditorius*, was very capacious. But 'twas observed, that, when our Subject began to grow ill, the Verge or Rime of the outward Ear seemed to be crimped; and, when it dyed, to be so shrivell'd, as if burnt up, not making a smooth, but a jagged Edge.

The upper Jaw was somewhat longer than the under, the Nostrils were large, the Eyes black, small, vivid, and exerted, when alive; now dead very much sunk. The Neck was short, and the Breast broad. It had *Mustachio's* like a Cat. The Fur upon the Face was shorter and whiter than the rest of the Body; on the Back and Sides it was of an Ash Colour or dappled with black Hair in spots, intermixt with white, especially on the Back; on the Belly 'twas more of an Amber Colour. and of a darker on the Legs. The longest Hairs, which were stronger and courser than the rest, measured 3 *Inches*; being white towards the Ends, but perhaps the Fur may vary in different Subjects.

Fig. 258. At the Bottom of the *Belly*, in the middle, between the two *Hinder Legs*, we observed a Slit or Aperture, moderately extended about 2 *Inches* long; capable of a larger Extension, by dilating it with ones Fingers, even when it is alive. It can so exactly close and contract it, that the Eye does not readily discover it. On each side of this Aperture there is a Reduplication of the Skin inwards, which forms a Hairy Bag: But the Hairs here are so thinly set, that almost every where you may observe the Skin. All Authors agree, that the use of this Bag, Pouch or *Marsupium*, is for the Preservation of the young Ones, and securing them upon any Occasion of Danger: And the Design of Nature is admirable in forming and adapting this Part so suitably to that End. There are two remarkable strong Bones not to be met within any other Skeleton, which from their Office I take Leave to call *Ossa Marsupialia*, or *Janitores Marsupii*. These Bones are so fastened

Fig. 257.

Fig. 260.
15. 15.

fastened to the upper and inward *Edge* of the *Offa Pubis*, that at their Basis *Fig. 261.* here they touched one another, just at the *Coalition* of the *Bones* that form the *Offa Pubis*; The other Extremes of these *Bones* were so distant from one another, that it measured $2\frac{1}{2}$ Inches. The Basis of these *Bones*, where joined to the *Offa Pubis*, was $\frac{1}{2}$ Inch broad, having 2 Heads, the larger lying near the *Coalition* of the *Offa Pubis* and the lesser towards the *Os Coxendicis*; having in the Middle a *Sinus* into which was received a Protuberance of the *Offa Pubis*. By this Contrivance it appears, there can be no Motion of these *Bones*, nearer or farther from one another, but that they must stand always at an equal Distance: Nor did I, upon Trial, find it otherwise, but observ'd they were capable of a small Motion inwards, towards the *Spine*, and outwards from it. These *Bones*, as they ascended from the *Os Pubis*, grew Slenderer, being about the Middle but $\frac{1}{4}$ of an Inch broad: and they were each 2 Inches long. To these *Bones* there were bestowed 4 Pair of *Muscles*, and there was another Pair that did run over them, to which these *Bones* did perform the Office of a *Trochlea*. The first Pair of *Muscles* (i.e. which first came to be dissected upon the Pronation of the Animal, and which from its Figure I shall call *Triangularis*) arises fleshy from the whole Length of the internal side of these *Bones*, and inserted their opposite *Tendons* on each side of the *Rima*, or *Aperture* of the *Marsupium*. Under Part of these *Muscles* lay another, or a 2d Pair, flat and thin, having their Origin from the upper Part of the Internal Side of the *Offa marsupialia*, and inserting their opposite *Tendons* a little above the *Tendons* of the former *Muscles*. The Tendency or direction of the Muscular *Fibres* of this Pair, in Relation to the first, made a Decussation. The third Pair of *Muscles*, we shall take Notice of, had their Rise from the Fore-part of the Basis of these *Bones* where they were joined to the *Os Pubis*, and were afterwards inserted into the *Linea Aspera* of the Thigh-bone. The Fourth Pair did arise from the external Side of these *Bones* near the Basis, and are inserted into the Fore-Part of the Thigh-Bone near the Middle. The last Pair of *Muscles* arises more immediately from the *Marsupium* or Pouch it self. For spreading their Muscular *Fibres* all over this Bag, as they issue from it, by Joyning their *Fibres* together, they more remarkably form a *Solid Muscle*, which of each Side passing over the middle of these *Bones*, (i.e. in the Prone Posture we are dissecting it) at length were inserted into the *Spine* of the *Os Ilii*. The two first of these *Muscles* must serve towards the *Dilation* or opening this *Marsupium* or Pouch; For these *Bones* are a *Fulciment* or *Basis*; their Articulation will not admit of a *Contraction* inwards or nearer to one another, wherefore, when the first and second Pair of *Muscles* act or contract, they must necessarily Open or Dilate the Mouth of the *Marsupium* or Pouch. The third and fourth Pair of these *Muscles* may serve to extend these *Bones* outward; so that, when this Animal hangs by its Tail (as it does frequently) the weight of the *Fetus* in this Pouch, by this Means will not press so much upon the inward *Viscera*. The Fifth and last

last Pair, as they may serve to Dilate the Capacity of the Pouch it self, so likewise may serve the better to suspend its Weight, when the Animal is *prono Capite*, and if it gravitates too much, they may retract it up, and the easier, because, passing over these Bones like a Pulley, their Force is more Augmented. The *Antagonist* to their Muscles is the *Spinster marsupii*, an Oval Series of strong Flethy Fibres, which serve to constrict and close the Orifice of the Pouch; which it does so perfectly, (as I have already observed) that one would think the Skin here not to be slit.

Fig. 259.
A.

The Pouch, or *Marsupium* it self, was a membranous Body, not very thick though consisting of several Coats: And is to be reduced into the Class of the Vesiculous Parts of the Body; which according to my Notion are Part Muscles, Part Glands; and do perform the Office of both Motion and Secretion. For the Concave or Hollow of this Pouch (as I have remarked) was somewhat Hairy, and at several Places I could observe them Matted or Cling'd together by a yellowish Substance, which did Ooze out of the Cutaneous Glands there; as under the Arm-pits of a Man, it is Observed.

This Liquor, thus emptied into the Pouch from the Glandulous Coat, I found was strong-scented, and had more of the peculiar *Fætor* of this Animal, than any Part besides: Being no ways grateful, but unpleasant to the Smell; as has been observed of this Creature when alive. But, after the Skin with the Pouch had been kept for some days, and was grown dry, I found so great an Alteration here in the Smell, that what before was so disagreeable, now was become a perfect *Perfume*, and smelt altogether like *Musk*; which made me call to Mind what formerly I had Remarked of these *Scent Bags* in other Animals. And I am apt to think that 'twas by Removing this *Marsupium*, rather than taking away the Kidneys, that these Animals are made Edible, which otherwise stink so much, that the *Barbarous Nations* refuse them, as out of *Lerius Job. Faber* takes Notice; for I could not smell in the Kidneys, or Fat about them, any thing ungrateful or ill-scented. This *Marsupium* had likewise a Muscular Coat, besides several other Muscles bestowed upon it, which we have observed already that gave it Motion. It had likewise a Vascular Coat too, being plentifully irrigated with Blood Vessels; especially by two large *Branches*, that came from the upper Part of the *Thorax*, and might be reckoned the *Mammaria*, as they are styled in other Animals.

Vid. sup. §
168.

This Pouch was fastened by several Membranes to the Muscles of the *Abdomen* and the Skin, but so as I could separate it for the most Part with my Fingers.

In this *Marsupium*, or Pouch, most Authors place the *Mamma*, or *Teats*; and they tell very odd Stories about them: But upon what Observation I could make, I did not find any *Teats* here; nor indeed could I find them in the outward Skin, as is usual in other multiparous Animals.

Possibly

Possibly this Subject never had a Litter, so for want of drawing they might be less, so as to Escape our View. The Male also, (if we may believe Piso, or the Author of the *Present State of his Majesty's Territories in America*, has such another Purse under his Belly, and takes his Turn to carry the Young ones, to ease the Female.

This Contrivance of Nature for Securing the Young ones from any danger, till they are able to shift for themselves, I think is not to be Parallel'd in any *Species* of Animals, at least of the *Quadruped Kind*, besides

Oppianus indeed, in his Excellent *Poem* of Fishes, tells us of the Dog-Halicutic. Lib. 2. *Fish*, that upon any Storm, or Danger if pursued, the Young ones run into the Mothers Belly, and when the Fright and Danger is over, they come out again; he also instances the same care in the *Squatina* and the *Glaucus*, tho' these receive their Young into different Receptacles: But if there be any Truth in these Stories, 'tis requisite that it were confirm'd by more Evident Proof and Observation.

In the *Thorax* of the *Possum*, I observed that the Lungs had 3 Lobes on one side, and but one on the other: But this One was as large as the other Three. They were soft and Spongy and easily Dilated and large, proportionably to the Animal. The Heart was included in a *Pericardium*; as usual, but the Heart it self I thought proportionably larger, in respect to the bulk of the Body, than is commonly, nor was it's Cone so sharp, but rather more Obtuse. It had two *Auricles* and two *Ventricles*. About the Throat there were large *Glandula Maxillares*, the Tongue was a little above 3 Inches long, and about $\frac{1}{4}$ of an Inch broad; 'twas Rough, having Protuberances whose Points looked inwards; the Voice, or Noise it made, was a little Growling.

The *Abdomen*, or *Belly*, was divided from the *Thorax*, or *Breast*, by a large, strong, fleshy *Diaphragm*: For the Compass of the *Thorax* in this place was very great and large, which might be rendred so the more, by Reason it often hangs by it's Tail, and, when it does so, the *Viscera* in the *Abdomen* can't but press upon it.

The *Ventricle* or *Stomach* something resembled the Figure of a Half Moon Fig. 263. B. 8. as usually: But the two Orifices of the *Gula* and *Pylorus* were placed so near one another, that they seemed to touch or meet; and, when I opened the *Stomach*, I found only a very slender *Isthmus*, or *Wall* parted them. These Orifices were inserted almost in the middle of the upper part, but more inclining towards that, that respects the *Duodenum*. It appeared but small, being much contracted; for it had not eaten any thing for some Days; it measured about $3\frac{1}{2}$ Inches in length, and about 2 Inches in Depth. The *Gula*, which conveys the Food into the *Stomach*, consisted of strong Muscular Fibres, and was in all about 9 Inches in length. The *Pylorus*, that carries out, seem'd to have its Passage free and open, without that *Annular Constriction*, or *Value*, as in most other Animals; though here we observed a larger Body of Muscular Fibres, than in other Intestines.

At

Fig. 263. C.

De Glandul
Intestin.Comparative
Anat. of the
Stomach and
Guts.

At one side I observed a *Perforation*, or Hole through, about the bigness of an ordinary Pea, and round. That this was occasioned by an *Ulcer* here, I plainly perceived by the Lips or Edges, which were not fresh, but had an *Ulcerated* Matter about them; and this, without doubt, was the Occasion of its Death; for it had fallen from its Food, and had Pined away for some Time before, and by its uneasy Motion made its keeper suspect, it had swallowed something that stuck in its Throat, or injured its *Stomach*. A like Accident I have three times met with in the Dissection of *Human Bodies*. Perhaps some of the *Glands* in the *Stomach* (such as *Payerus* and *Dr. Grew* describe in the *Intestines* (being become *Scrophulous*, or *Steatomatous*, might *Impostumate*, and so *Corrode* the Coats of the *Stomach*, and Cause this *Perforation*: And the rather I am of this Opinion, because I found in other Places of the *Stomach* these *Glands* very large and *Steatomatous*; though naturally they are but small and often not Observed. Where there is a *Perforation* of the *Stomach* upon an *Inflammation*, and upon that an *Impostumation*, there the *Foramen* is larger and not regular; as remarkably I once met with it in a Child, where a larger part of one side of the *Stomach* was *Sphacelated*. So likewise upon a *Corrosive Poison* taken, its effect dilates itself more, and is not confined to so narrow a Compass, as I observed once in one who had taken *Rats-Bane*,

Fig. 266.

There was nothing contained in the *Stomach*, but a Body of Clotted Hair, formed into the Shape and Figure of the *Stomach*, somewhat like an *Half-Moon*; covered with a Slimy *Viscid* Substance, which did serve the better to glue these *Hairs* together. These *Hairy Tophi* are frequently to be met with in the *Stomachs* of *Oxen*; and the *Butchers* inform me, that they chiefly meet with them in the Winter Season, after the *Hair* begins to shed, and the *Cattle* feed upon Hay or dry Meat; but after the Spring, and in Summer, they do more seldom find them, as if the *New-Grafs*, which Purges them, did contribute to dissolve these *Tophi* likewise. But our Animal is *Carnivorous* and (in which all Accounts agree) most *Rapacious* of the *Winged Kind*; and, where it can't find its Prey on the Land, it will hunt for it in the *Trees*, most nimbly Climbing them up; and if the tender Bough cannot Bear the weight of its Body on its Feet, by twisting its Tail about the Twig it can hang thereby, and stretch it self the farther, to obtain its desired Food, or rob a Nest. Nay, if I am not misinformed, by this means it can Fly, or pass from one Tree to another, without descending; for thus hanging by its tail, and waving and swinging its Body like a *Pendulum* it can fling it self into the Boughs of a Neighbouring Tree, where his Tail is sure to take fast hold of the first Bough it lights on, if otherwise it misses its Footing; and, as I have shewn, his hinder Leg being made like Hands with a Thumb, it can more readily raise its Body up by them. But, though these Animals be *Carnivorous*, yet when *Need* drives them, they can take up with other Food; for this we dissected would Eat any thing that was brought from the Table.

The *Mesentery* is that *Membranous* Part, which Colligates the *Intestines*, and fixes their Situation, and gives to them the Order of their Figure. Fig. 163. For the *Intestines* are not just fastened to the *Peripherie*, or outward Circumference of the *Mesenterie*; but the outward *Membrane* of the *Mesenterie* of both sides is entirely Projected and continued over the whole *Canalis*, or *Duct* of the *Guts*; and is to them the outward or common *Membrane*. So that often, by separating this outward *Membrane* from what lies under it, the *Muscular*, I have Extracted the whole length of the *Guts*, leaving only the common *Membrane*, as 'tis continued from that of the *Mesenterie*, which I could Inflate, as if the whole of the *Guts* remained. Now here we observed that Remarkable Difference from what is in many other Animals, that we cannot but make two *Mesenteries*: one peculiar to the small *Guts*, the other belonging to the great Ones.

The former I shall call *Mesenterium Minorum*, and the latter *Mesenterium Majorum Intestinorum*: For, as the *Duodenum* descended from the Stomach, it ran under the *Colon* (just where 'tis joined to the *Cacum*) towards the middle of the *Spine*. Hence I found a Projection of the first *Mesenterie* into a Spiral Line, like a *Cochlea* or Winding Pair of Stairs: So that upon Inflation these *Intestines* here made several *Convolutions*, tho' not exactly *Spiral*. The second *Mesenterie* was Projected more in a Plain; and made almost a Circular Figure at its *Peripherie*: So that the *Cacum*, and *Colon*, did almost entirely Encircle the small *Guts*.

The Reverse of this Structure of the *Intestines* I formerly found in the Anatomy of the *Tajacu*, for there the *Colon* made a *Spiral* Figure, and the small *Guts* made a Plain. Bnt this *Spiral Convolution*, of the *Intestines* is also to be met with in several other Animals, though their Structure be different; as in the *Goat* and *Deer* kind; and very remarkably in a *Woodcock*. Vid. Sup. §. CVIII.

The small *Guts* measured about $6\frac{1}{2}$ Feet in length; the *Cacum* was about 6 Inches long; and the *Colon* and *Rectum* 2 Foot long. The Girth of the *Duodenum* (I mean all along here as inflated) was 3 Inches; the *Ilium* $2\frac{1}{2}$ Inches; the Girth of the *Cacum* in the largest place was 6 Inches; of the *Colon* 4 Inches: And the *Rectum* was 3 Inches about. From the *Spine* to the utmost Projection of the small *Guts*, (under the same Circumstance of Inflation) we measured about 6 Inches, the greatest Diameter, that the *Colon* in this Circular Figure made was somewhat above 7 Inches. In the whole *Duct* or *Canalis* of the *Intestines*, I could not observe any *Valves*, no not at the *Cacum* it self. 'Tis True, that the *Foramen* into the *Cacum* was a great deal less then the Capacity of the *Gut* it self: However the Passage into it was so open and wide, as readily to Receive or Emit its Contents.

But the Length and frequent *Gyrations* and *Windings* of the *Intestines* supply this want of *Valves*; they prevent the Danger of a too hasty Descent of the *Feces*, and gave a greater Opportunity to the Separation of the *Chyle* into the *Vasa Chylifera*. And the *Cochlea* or *Spiral Figure* of the First *Mesentery*

Mesentery easily Prevents the *Regurgitation* of the Contents of the *Intestines* again into the *Stomach*, upon a *Declivity* of the *Body* of this *Animal*, as it is frequently in, when it hangs by its *Tail*. For tho', as I observed, the *Passage* from the *Stomach*, by the *Pylorus* into the *Duodenum*, is large and open, yet in the *Posture* of the *Body* there cannot but be a *Reduplication*, or folding over of the *Duodenum*; since the great Bulk or *Wallet* of these *Intestines* must incline and *Swag* towards the *Diaphragm*: By which *Reduplication*, the *Passage* at the *Pylorus* must, in a great Measure, be *Occluded*; and the *Ascent* of the *Contents* now, be altogether as difficult and great, as when the *Animal* stands upon its 4 *Feet*.

Fig. 267 BBB

The *Pancreas* was large, having one part (if I misremember not) running towards the *Spleen*, and the other down by the *Duodenum*. The *Liver* was very large of a *Bright Red* Colour, consisting of 3 *Lobes*, two of them were much larger than the third, which was not to be seen, but upon inverting the *Liver*. And here we found not only at the *Edges* of one of the larger *Lobes*, deep *Incisures*, which rendred it *Jagged*; but also in the middle of the *Concave* part of the same *Lobe*, several deep *Fissures*; possibly for this Reason, that so it might yield and give way the better, when 'tis inverted, as 'tis always, when this *Animal* hangs by its *Tail*. The *Bladder* of *Gall* was very large. The *Kidneys* of each side were a little above an *Inch* and half long, about $\frac{1}{4}$ of an *Inch* broad, and of the *Figure* almost of a *Kidney Bean*. The *Emulgent veins* and *Arteries* were very plainly *Seen*: But on inside of the *Kidneys*, towards the upper part, were placed the *Glandulae Ranales*, which were very large and of the same Colour with the *Kidneys* themselves, which was a deep *Red*.

Fig. 264 AA

Fig. 364. f

The *Ureters* were about $5\frac{1}{2}$ *Inches* long, and were inserted into the *Neck* of the *Bladder* of *Urine*, as is represented, first running under, then *Ascending* up by the two *Extreams* of each *Uterus*, as they lie *Duplicated*. The *Bladder* of *Urine*, being inflated, was about the bigness of a *Hen's Egg*, and of that *Figure*. The *Neck* of the *Bladder* or *Urethra*, (which was about an *Inch* long) lay over the *Vagina Uteri*: and here the *Urethra* and the *Vagina Uteri* *Emptied* themselves into one *Common Canalis* or *Passage*, which measured about an *Inch* and half in length. In most *Animals* about the *Kidneys* there uses to be observed a large *Body* of *Fat* *Covering* them, being contained in the *Membrana Adiposa*: But here we found 4 large *Protuberant Lumps* of *Fat*, two of each side; two of them lying in the *Pelvis* of the *Abdomen*, near the *Bladder* of *Urine*, and the *Uterine Parts*, and the two others between them and the *Kidneys*.

They consisted of *Regular large Lamina*; which were easily *Separable* from one another, in broad *Flakes*, so as I have never observed before.

Fig. 264. 265.

Amongst the *Uterine Parts*, which were very surprising, we found *Two Ovaria*, *Two Tuba Fallopiana*, *Two Cornua Uteri*, *Two Uteri*, and *Two vagina Uteri*. The *Ovaria* were placed one of each side near the *Extreams* of the *Cornua Uteri*, being fastened to the *Ala Uteri*, and were about the bigness of a *vetch*. The *vasa Præparantia* (the *Artery* and the *Vein* that did go to and from them) were very plain, and as I have represented them; though the greatest part of

of these *Vessels* were bestowed upon the *Cornua Uteri*. Near the *Ovaria*, I observed the *Fimbria Foliacea*, and thence a Passage into the *Tuba Fallopiana*. Fig. 264.
nnn. 0000. The *Tuba Fallopiana* were two fine slender *Canales* or *Ducts*, supported by the *Ala Uteri*, and running waving, and led into the Extreams of the *Cornua Uteri*. The *Cornua Uteri*, being inflated, were about the bigness of a *Goose Quill*, about an Inch and half long; and were fastened to the *Ala Uteri*, towards both Ends a little Crooked, but where they pass into the *Uteri*, they were reflected inwards, and at the other Extream Reflected outwards. Their Substance seemed rather thicker than the *Uteri* themselves, and not so Transparent, by Reason of the numerous *Blood Vessels* which irrigated them almost all over; for in the inside, both above and under, there ran the whole length of the *Cornua*, large *Trunks* of *Blood-Vessels*, sending from the sides all along Numerous Branches, which is very requisite: For in Animals that are *Multiparous*, as in our Subject, (having 5 or 6 Young ones at a time) the *Litter* or *Fætus* do lie, and are formed in the *Cornua Uteri*. And I did here take Notice, of some little Rifings of the inward *Membrane* of the *Cornua*, whereby they were somewhat divided into Cells, but very imperfectly. However for the Nourishment and Formation of the *Embryo's* here, so great a number of *Blood Vessels* is highly necessary, and they were far more Numerous here than in the *Uteri* themselves. These two *Cornua* do Empty themselves into the two *Uteri*, just in the middle where they are Conjoined together, and Fig. 264. xx
Fig. 265. cc so outwardly seem to form but (as it were) one continued Body. In *Lob-* vid. sup. *sters* and *Crabs*, in the Female there are two *Uteri*, as in the Male there are two *Penes*; so two *Penes*, and each Forked too, I have observed in the *Rattle-S-* XLIII *Snake*: But I think this is the only Instance of a *Land Quadruped*, that has two *Uteri*; and each of these too, seemingly double by the *Reflexion* they make, and by an Imperfect *Diaphragm*, which divides the Cavity of each *Uterus* a considerable way.

These *Uteri* are not fastened to the *Ala*, as are the *Ovaria*, *Tuba* and *Cornua*; but where they are Conjoined near the Insertion of the *Cornua*, they do Adhere very firmly to the Neck of the *Bladder*, not easily to be separated thence; and by a *Membrane*, to the *Rectum*, where they are more separable. So that the Neck of the *Bladder* lies over the *Diaphragm*, or *Membrane*, which parted them (as I said) into two Distinct *Uteri*. Here the Body of the *Uteri* measur'd in Compass (thus Inflated) was about $1\frac{1}{4}$ Inch: Hence they were Projected towards each side, and not according to the length of the *Spine*, gradually enlarging the inward Cavity, as 'tis extended; for here about the Angle of *Reflexion*, if measur'd in Compass, two Inches and an half. The *Uteri* being thus extended towards each side about the space of $1\frac{1}{4}$ Inch, are then Reflected back again towards the Neck of the *Bladder*, and so pass into the two *Vagina* which lie under the *Urethra*. From this Angle of Reflexion, the Cavity of each *Uterus* gradually Lessens, and is much smaller than the other parts of the *Uterus*; the Capacity of each *Uterus* being the largest at the outward Elbow, where it begins to be Reflected, for here it was made, as 'twere, one Common Cavity for almost

the length of an Inch. But on the inside, I observed a *Membrane* to be Projected from the Internal side of the *Uteri*, just from the Corner where the sides of the *Uteri* are Doubled, whereby this Cavity is in part divided; and for this Reason, shall call the *Membrane*, the *Second*, or an *Imperfect Diaphragm* of the *Uteri*. In these *Uteri* I observed four large *Trunks* of *Blood Vessels*, which did run the whole length of them, sending from their sides Numerous *Branches* and *Ramifications* all along. These *Trunks* were Propagated from the *Hypogastrick* and *Spermatick Vessels*. I did also here observe in these *Uteri* (this by *Inflation* extended and dried) several *Fasculi* of *Muscular Fibres*, placed at a Regular Distance from one another; which did run the whole length of the *Uteri* likewise: By means of whose *Contraction* the *Fœtus* may be more easily forced out.

These two *Uteri* Empty themselves into the two *Vagina*; for at this Extream, the *Uteri*, making a *Turn* at the *Neck* of the *Bladder*, are continued thence into the two *Vagina*, which lie just under the *Urethra*, and are much of the same length with it, which was about an *Inch*. Their Capacity was about the bigness of a *Wheat-Straw*: Both these *Vagina*, and *Urethra* too, Emptied themselves into a *Common Passage*, or *Canalis*, which was as large as all the other three, and about $1\frac{1}{2}$ Inch long. It looked Reddish by means of the Numerous *Blood Vessels* it enjoyed, and at last had its Exit so near the *Fundament*, that, when alive, there was not observed any other *Foramen* outwardly, but that which led into the *Rectum*: But when I came to Dissect it, by Elevating the Skin here, which seemed to cover it like a *Valve*, I observed the *Foramen* that led into this *Common Passage*, and putting a Blow Pipe into it, at the same time, by *Inflation*, I extended the *Bladder* of *Urine*, and the *Uterine Parts* too, viz. The *Vagina*, the *Uteri*, and the *Cornua*. So that in the Skin here, there was only one *Foramen* for the Exit of the *Fœtus*, and the *Urine* and the *Fœtus* too.

I have not had an Opportunity of Dissecting a *Male Possum*; and the Account we find of it in Authors is very short and Imperfect, so that Mr. Ray, with good Reason, Queries whether the *Tai ibi* of *Brazile*, described by *Margrave*, differs from our Subject, the *Possum*, only in Sex.

The *Skeleton* of the *Head*, from the End of the *Occiput* to the Extream of the *Nares*, was 4 Inches and $\frac{3}{4}$ long, of which the *Rostrum* measured three Inches, and just where the *Rostrum* and the *Cranium* met, the Bones were so Pinched in at the sides, that here 'twas very narrow; and I may say, in proportion to the Bulk of the Animal, this was the least *Cranium* I ever met with in a *Quadruped*. On the *Fore-head*, the *Rostrum* was an Inch broad, having on each side, a *Protuberance* jetting out. There was a large *Sutura* just in the middle, which divided the upper Bones of the *Nares* lengthways; and though they run slender towards the Extream of the *Nares*, yet these Bones towards the *Fore-head* spread into a *Triangular Figure*, and as they are jointed together, they form a *Rhomboide*, or a *Lozinge*. There was a Remarkable Rising Ridge like a *Crest*, that runs the length of the *Cranium*, from the *Fore-head* to the *Occiput*, just in the middle, where the *Sutura Sa-*
gittalis

gittalis is in other *Skulls*. This Ridge, for Distinction sake, I shall call, *Protuberantia Ossea Longitudinalis*; and I observed, it jutted out from the *Cranium*, above a Quarter of an Inch. Just at its upper Edge, I could perceive a *Seam* like a *Suture*: So that, though now these Bones are so well united together, that they appeared as one entire Body, yet in the *Fœtus*, without doubt, they are separable, and are two; and this I rather think, because in the upper part of the *Cranium* I could not find any *Sutures* at all. So likewise answerable to the *Lambdoidal Suture*, may be those other *Ridges* in the Extream of the *Occiput*, which I shall call *Protuberantia Ossea Laterales*: Which arising on each side from the *Processus Styloides* ascend oblique up the hinder part of the *Occiput*, and just in the middle in the top are joyned with the *Longitudinal Ridge*, I have described. These *Ridges*, although as deep as the first, yet were not standing so upright, but Projected rather like a *Pent-House*, over this hinder part of the *Cranium*; By both which *Ridges*, the *Cranium* is so well Guarded and Defended, that 'tis almost impossible, the *Skull* should be any ways Cracked or Broken. Something like these *Ridges*, but nothing so large, I have observed in the *Skull* of a *Weasel*. The *Eyes* likewise are very well Guarded and Defended by the *Os Zygomaticum*; which is very broad and strong, in the broadest place being above $\frac{1}{4}$ of an *Inch*, and in the narrowest half an *Inch*, being very thick on its under Edge, but at its upper, growing thin and sharp. But for the greater strengthening this Bone, (which is formed by a *Process* from the *Os Temporum*, and another from the *Maxilla Superior*) where they meet they lap over one another, and so become the Stronger. This *Os Zygomaticum* was $2\frac{1}{2}$ *Inches* long, and standing off from the *Cranium* an *Inch* in distance. In the *Orbit* of the *Eye*, at the *Inward Canthus*, there was a large *Foramen*, which led into the Cavity of the *Nose*; and by a *Duct* placed here, the *Tears*, or *Moisture* from the *Eyes*, are conveyed into the *Nostrils*. In the upper *Jaw Bone* likewise, there was a large *Foramen*, which was for the Passage of some *Vessels* from the inward *Orbit* of the *Eye*. The *Cranium*, which encompassed the *Brain*, in the largest place, was about an *Inch* over, and about an *Inch* and half in length; but its Cavity jutted out somewhat farther towards the *Nares*, making as it were, a particular Cell here, and pretty Capacious, for the receiving the *Processus Mammillares*, and that Fore-part of the *Brain*. And afterwards I observed the *Os Cribriforme*, very remarkably Perforated with Holes like a Sieve; and indeed, in forming this *Organ* of Smelling, nature seems very Careful, and Sollicitous, the *Rostrum* making so great a part of the Head, that the *Cranium* it self seemed very inconsiderable in respect to it, its inward Capacity containing not above the Quantity of a *Walnut*. The *Os Spongiosum* in each *Nostril* seemed very Curiously contrived by the abundance of *Lamina* it enjoys, so that the *Membrane* that covers them, by this means, is rendered more Capacious, and Capable of receiving more plentifully the *Effluvia's* of those Animals, it would either Catch, or Avoid: and in this *Sensory* 'tis known that *Brutes* excel even Man himself, and their *Organ* is more Adapted for it.

The under Jaw consisteth of two strong Bones, joyned together only at the *Mentum*, each measured 4 Inches in length. The Head of this Bone (which was half an Inch broad) was received into a *Sinus* of the *Os Temporum*, and very firmly *Articulated* there. It had two *Processus*, the *Anterior* or *Superior* is large and thin, into which is inserted the *Temporal Muscle*: The *Inferior Processus* is smaller, and runs to a sharp Point. Here at this *Processus*, the Edge of the *Mandible* is so Dilated, that it measured above half an Inch. On the inside of the Jaw there is a large *Sinus*, which leads to a *Foramen* that goes into the Body of the Jaw-Bone, and affords a Passage for the *Vessels* thither. In the upper Jaw before were 8 small *Dentes Incisores*, 4 of each side; then a *Void Space*, almost a quarter of an Inch, then two large Prominent *Dentes Canini*, one of each side, which Jutted out of the Jaw about half an Inch, these were succeeded on each side, with 3 *Dentes Incisores*: but these were much stronger and larger than the *Fore teeth*, and imitated the *Dentes Molares*, were Flat and almost of a *Triangular Figure*; there were 4 *Dentes Molares*, on each side, in all 24 *Teeth* in the upper Jaw. But the *Double Phangs* of the *Molares*, and the *Incisores Majores*, were such as at the first Sight, one would think them two Distinct *Teeth*, each *Phang* being inserted into a Distinct *Alveolus*, or *Socket*, in the Jaw, and remaining separated some way above the Jaw-Bone, and only joined at the Head. in the under Jaw-Bone, there were likewise of each side, 4 *Dentes Incisores Minores* before, then a little *Void Space*, after that, the *Dens Caninus*, then 3 *Dentes incisores Majores*, and last of all 4 *Dentes Molares*, answerable to those in the upper Jaw, but somewhat smaller. In both Jaws, in all 48 *Teeth*.

There were 7 *Vertebra* of the Neck, 13 of the back or *Thorax*, 6 of the *Loins* 3 of the *Os Sacrum*, and 22 of the *Tail*, 51 in all. The First *Vertebra* of the Neck, (to which the Head is fastened, and is therefore call'd the *Atlas*) had two Broad Transverse *Processes*, but no *Spine*. The 2d *Vertebra* of the Neck had a very large and thick *Spine* of a *Triangular Figure*: And in it was observed a large Semi-circular *Sinus*, which was so deep as to receive into its Bosom a great part of the First *Vertebra*, by which means the *Articulation* was very much strengthned. This *Vertebra* is called *Dentata*, from that *Tooth-like Protuberance* I have represented, and which is receiv'd into the Hollow of the First *Vertebra*, where the *Medulla Spinalis* runs. This *Vertebra* backwards, had two *Processus obliqui Superiores*, and two *Obliqui inferiores*. The 3d *Vertebra* of the Neck, had the same *Processes* both before and behind, but the *Spine* here was about 3 quarters of an Inch in height, about the 3d part of an Inch thick, and just at the top seemed to be a little Cleft. The 4th and 5th *Vertebra* had the same *Processes*, as the 3d *Vertebra*, and the *Spine* here likewise was very thick and Cleft to the top, but gradually lessening in height, as also thickning. The 6th *Vertebra*, besides the former *Processes*, had likewise an *Acute Transverse* one on each side, and its *Spine* much shorter and more *Acuminated* than the former. The 7th *Vertebra* of the Neck had only two *Oblique Processes* before, and none behind, and two *Acute Transverse Processes*, and a very short and sharp *Spine*: So that upon holding

Fig. 268.

Fig. 368. d.

Fig. 269.

ing up the *Head*, the *Spine* of the first *Vertebra* of the *Thorax* would touch the top of the 5th *Vertebra* of the *Neck*. These *Vertebra* are so strongly and closely locked into one another, that tho' each of them are large in themselves; yet thus articulated, they do not make full 2 *Inches* in length. This thickness and Strength of the *Vertebra* of the *Neck*, and likewise of several of the *Vertebra* of the *Thorax* and *Loyns*, and the prominent bony Ridge in the *Cranium*, so well secure his *Neck*, *Back*, and *Head*, that should it happen to fall to the *Ground*, there would be no Danger of breaking any of them.

The first 7 *Vertebra* of the *Thorax*, have 3 *Oblique Processes* forwards, which Fig. 270. run under the hinder *Oblique Processes* of the preceeding *Vertebra*, and have two *oblique Processes* backwards, which ride over those of the succeeding *Vertebra*; as likewise two *transverse Processes*, which at their Ends have small *Acetabula's* or *Sinus's*, for the receiving the Heads of the *Ribs*, which are fastened to them. The *Spines* of these *Vertebra* are slender thin, and sharp, about $\frac{1}{2}$ of an *Inch* long. The 6 following *Vertebra* of the *Thorax*, have short, thick, and flat *Spines*, the *oblique Processes* being continued on each Side of the *Spine*, make, as 'twere a *Gutter*; and the *transverse Processes* here, are somewhat different from the former. The *Spines* of the *Vertebra* of the *Back*, or *Loyns*, Fig. 271. the more they approached the *Os sacrum*, so they lessened gradually in their Thickness on the Edge. But here were double *oblique Processes*. viz. 4 at each end of the *Vertebra*, and the undermost spreading themselves out broad. The 3 *Vertebra* of the *Os sacrum*, are firmly fastened to the *Os Ilium*, but the last not so entirely as the two former. But this at each side had a broad *transverse Process*, and the *Spines* of these were thin, the two first *Vertebra* of the *Tail* had only one small *acute Spine*, but in all the other *Vertebra* of the *Tail*, both at the *Head* and *Tail* of each *Vertebra*, I observed two *Spines*, but those at the *Head* of the Joint the larger. In the 6 first *Vertebra* of the *Tail*, there was on each Side, a broad *transverse Process*, the length of the Joint; In the other *Vertebra*, only at the *Head* and *Tail*, a Jutting out at the sides. The *Vertebra* about the middle of the *Tail*, were the longest; being there about an *Inch* long; near the *Root* of the *Tail*, and at the *End*, not so long.

The *Spines* or *Hooks*, placed in a Line in the Middle of the Underfide of Fig. 272. the *Vertebra* of the *Tail*, are a wonderful Piece of Nature's Mechanism. 'Tis true, the first 3 *Vertebra* had none of these *Spines*, but in all the rest they were to be observed; but as they approached the extremity of the *Tail*, they grew lesser and shorter; these *Spines*, where longest, were about $\frac{1}{4}$ of an *Inch*, or somewhat more. They were placed just at the *Articulation* of each Joint, and in the middle from the Sides, and seemed to be articulated, both to the preceeding and following *Vertebra*, not being an entire solid Body, but arising from the *Vertebra* with two Legs or *Crura*, become afterwards perfectly united at the Ends. By this means, the Bones are rendred more firm and strong, and this *Hollow* serves for the transmitting of the Blood-Vessels through them; and one may observe here a *Stria*, or *Furrow*, all the Length of the *Vertebra*, for the receiving them, whereby they are the better secured from Compression, when this Animal hangs by its Tail. And for the

the performing this Office, nothing, I think, could be more advantageously contrived; For when the *Tail* is twirled or wound about a Stick, this *Hook* of the *Spine* easily sustains the Weight, and there is but little Labour of the *Muscles* required; only enough for the Bowing or Crooking the *Tail*; for then, as by a *Hook*, the Weight of the whole body is hereby suspended. And for the doing this, 'twas observed, that in each preceeding *Vertebra*, there did a *Muscle* arise, which was inserted on each side of the succeeding *Vertebra*; which *Acting*, or *Contracting*, must necessarily bend and curve that Joint. But for the strengthening the whole, there were observed 4 *Muscles* to arise from the *Os sacrum*, which did run the whole length of the *Tail*; two on the upper side, and two on the under; founding each a Tendon to each *Internode* or *Vertebra*. So that when the Skin was stript off, the outward Parts of these *Muscles* seemed to have tendinous Expansions over them, the whole length of the *Tail*, and almost to be covered by them, which must needs very much contribute and add Strength to the *Tail*; besides what may be the Effect of their Insertion of *Tendons* into each Joint, or *Vertebra*, in curling and unbending the *Tail*.

Fig. 266. To the *Vertebra* of the *Thorax* are fastened the *Ribs*, and there are 13 on each Side. The 7 Foremost are more perfectly articulated with the *Sternum*, the 6 succeeding may be reckoned, in some sense, *Costa Notba*: For, though they are long, and as they proceed from the *Vertebra*, are inclined backwards towards the hinder Legs, yet afterwards they are reflected forwards towards the *Sternum* or *Cartilago Scutiformis*. And though in our Animals, that Part of the *Ribs* that is fastened to the *Os Pectoris*, or *Sternum*, be usually *Cartilaginous*, yet here, in our Subject, I observed it to be all *Bony* throughout. However, this Difference I found, that the *Ribs* did look redder, by Reason of the blood Vessels in them, and this Part was *Whiter*, as where it was fastened to the *Ribs* one might plainly see; so that it may well pass for a *Bony Cartilage*, as often the *Cartilages* do become *Bony*.

The first *Rib* was only an *Inch* long, and its *bony Cartilage* a quarter of an *Inch*: Hence gradually the *Ribs* increase in length, for the 7th *Rib* was 3 *Inches* long, and its *Cartilage* was one *Inch* and a half. The 4 last of the *Costa Notba*, gradually lessen again in length, for the last *Rib* of all was only one *Inch* and $\frac{1}{2}$ long; and its *Cartilage* did not run home to the *Os Pectoris*, or *Sternum*, tho' the first, second, and third, of the *Costa Notba* did. The *Os Pectoris*, or *Sternum*, consisted of 7 *Bones*, according to the Number of the Fore-Ribs that are fastened to them. At the beginning of the *Sternum*, there jutted out a sharp *bony Cartilage*, which, from its Figure I shall call *Cartilago Ensiformis*: And here was fastened one extrem of the *Cavicula*. At the End of the *Sternum*, towards the Belly there was a broad, roundish *Cartilage*, which therefore I shall call *Cartilago Scutiformis*.

There were two *Clavicula* or *Collar-Bones*, each an *Inch* and $\frac{1}{2}$ long, having one Extrem fastened to the first *Bone* of the *Sternum*, or the *Cartilago Ensiformis*, and the other End to the *Spine* or *Scapula*, near the Conjunction of it to the *Os Humeri*. By Means of this Bone, it can more advantageously bring

bring its Fore-feet to its Mouth, as it uses to do when it feeds it self, as do the *Monkey-kind*, who have *Clavicula* too as well as Man; tho' many Animals want these Bones.

The *Scapula* or *Shoulder-Blade*, was about 2 Inches long, and about an Inch and $\frac{1}{2}$ broad; its *Spine*, tho' thin, yet the nearer it approached the Shoulder, it grew larger and flatter. Into the *Sinus* of the Neck of the *Scapula*, was received the Head of the *Shoulder-Bone*, or *Fore-Thigh-Bone*, and to that Protuberance called the *Acromium* was fastened the End of the *Clavicula*. This *Thigh-Bone* of the *Fore-Legs* was about $2\frac{1}{2}$ Inches long, 'twas thick and strong, having a large rough *Spine* jutting forward and running half the length of it. The lower Extream of this *Thigh-bone*, to which was fastened the *Tibia* and *Fibula*, grew very broad, being almost an Inch broad. Above, where this Bone began to grow broad, on the outside was a large Protuberance, and on the inside there was a great oblong Foramen, or hollow Passage, formed by a small Bone arising from the inward Fore-part of the *Thigh-bone*, where it began to grow larger, and was afterwards united to that part of the Basis of this Bone, where the *Fibula*, or *Minus focile* is joined. Just in the middle of the Basis of this Bone, there was a large *Sinus* which backwards appeared deeper, which did look into another deep *Sinus* of the *Tibia*, by which Means these Bones were so firmly articulated together, as they were not easily, if possibly, to be put out of Joint. The *Tibia*, or *Focile majus*, was a strong Bone about 2 Inches long, which was extended upwards above $\frac{1}{2}$ of an Inch above its Articulation with the *Thigh-Bone*, and at the other End was fastened to the outward Bone of the *Tarsus*. The *Fibula*, or *focile minus*, was a smaller Bone, placed more inward and forwarder, and not so long as the *Tibia*, being Articulated above (but not so firmly) with the *Thigh-Bone*, and below, with the inward Bone of the *Tarsus*, for there were but 2 Bones of the *Tarsus*, having each a small *Sinus*, for the receiving the Heads of the two *Fociles*. The Bones of the *Metatarsus* were 4, or it may be 5, to which were joined the 5 Fingers or Toes of the Fore-feet. The innermost Toe had but two Articulations, or Joints, but at the End had a large, hooked, strong Nail; the other 4 Fingers had each 3 *Articuli*, or Joints, armed with hooked Nails, as the first.

The hinder Legs were fastened to the Trunk of the Body by the *Oss Innominatum*; which in the whole in a straight Line was 3 Inches long. In the Head of the *Hinder Thigh-bone*, and deeper in, there was a Space for the fastening the Ligament, from which space there was a *Sinus* which led outward; so that the Brims of the *Acetabulum* were not an entire Circle, but broken off here.

Here also are the *Ossa marsupialia*, or *Janitores marsupii*. The hinder *Thigh Bone* was a little above 3 Inches long, 'twas roundish and a strong Bone: But the *Tibia*, or *majus focile* of the hinder Leg, was somewhat longer, a little curv'd. The *Fibula*, or *minus focile*, was about the same Length, straighter and slenderer. This towards the Foot was articulated to the *Oss Calcis*.

Calcis, as the *Tibia* was to the *Talus* or *Astragalus*; and these two Bones I make the *Tarsus*; and joining to them were the Bones of the *Metatarsus*, and to these the *Phalanges* of the Fingers and Toes. In the innermost, or the Thumb, there were only two *Articuli* or Bones, in the other 4 Toes, or *Digiti*, in each there were 2 *Articuli* or *Joints*. The End of the Thumb was more flatted than the Ends of the other Toes: For the Thumb, as I have observed, had a flat Nail like a human Thumb: In the others, the Nails were long and curved. I observed likewise at the Articulation of each Joint of the Toes, on the under side there were two small Bones, that are called *Ossa Sessamoidea*, and these both in the Fore and Hinder Feet.

Explanation
of the Fi-
gures.

Fig. 257. Represents the *Possum* drawn from the Life.

Fig. 258. The *Slit*, or *Aperture* in the Belly, that goes to the *Marsupium*, or *Pouch*.

Fig. 259. *A.* the *Marsupium* turned the inside outwards, where may be observed the Hair or Fur that covers it, and may help the better to keep the young Ones warm. *BB.* the two Hinder Legs cut off. *C.* the Foramen of the *Anus*: Which is also the common outward Vent, or Exit, the *Rectum*, the Bladder of *Urine*, and the *Uteri* too. *D.* the Beginning of the Tail.

Fig. 260. The *Skeleton*. *AA.* the *Rostrum* or *Snout*. *bb.* the *Cranium*, or *Skull*, that did contain the *Brain*. *ccc.* A bony Ridge, or *Protuberantia Ossis Longitudinalis*, that did run the length of the *Cranium*, and over a Part of *Rostrum*. *d.* the *Lateral Ridge*, which, like a Pent-house, juttet over the hinder Part of the *Cranium*, *Protuberantia ossis Lateralis*. *e. f.* the *Os Zygomaticum*. *e.* its Process from the *Os temporum*. and *f.* that from the *maxilla superior*, open Jaw. *g.* A Foramen, or *Hole*, in the inward Canthus of the Orbit of the *Eye*, that leads into the *Nostrils*, and by a *Duct* conveys the tears, or Moisture of the *Eyes* into them. *h.* a Foramen, or *Hole* in the upper Jaw, for a Passage to the *Vessels*. *i.* A Protuberance of the *Os frontis*. *K.* A Suture of the *Os Narium*. *ll.* the lower Mandible or *Jaw-bone*, *maxilla inferior*. *m.* the superior Process of the under Jaw. *n.* the inferior Process of the under Jaw. *o.* the *Clavicula* of one Side. *p.* the *Cartilago Ensisformis* of the first Bone of the *Sternum*. *q.* the *Scapula*, or *Shoulder-Blade-Bone*. *r.* the spine of the *Scapula*. *SSSS.* the *Thigh-Bones* of all the Feet. *TTTT.* the *Tibia*, or *Focile majus* of all the Feet. *uu.* Part of the *Tibia* in the Fore-Legs extended beyond the *Articulation*. *WWWW.* the *Fibula*, or *Focile minus*, in all the Legs. *xxxx.* the Bones of the *Tarsus*. *yyyy.* the Bones of the *metatarsus*. *zzzz.* the *Toes*, *a a.* the *Thumbs* in the hinder Feet. 1. The first *Vertebra* of the Neck, called the *Atlas*, 2. 3. 4. 5. 6. 7. the 2d 3d 4th 5th 6th and 7th *Vertebra* of the Neck. 8. the first *Vertebra* of the *Thorax*. 9. the first *Vertebra* of the *Loyns*. 10. the first *Vertebra* of the *Os sacrum*. 11. the first *Vertebra* of the *Os coxigis*, or Tail. 12. 12. 12. 12. the *Spines*, or *Hooks*, on the inside of the Tail. 13. 14. the *Os Innominatum*, where 13 is the *Os Ilium*, 14 the *Os Ischii*, or *Coxendicis*. 15. 15, the *Ossa marsupialia* seu *Fanitores marsupii*, * * * *. the *Ribs*, 13 in all. © the *Cartilago scutiformis*.

Fig. 261. The Situation of the *Ossa Marsupialia*, &c. *aa.* the *Ossa Pubis*. Fig. 261.
b. the Coalition, or the joyning of the *Ossa Pubis*. *c c.* the Two *Ossa Marsupialia* or *Fanitores Marsupii*. *d e.* the Basis of the *Ossa Marsupialia*, where joined to the *Ossa Pubis*. *d.* the Inward Head of the Basis, *e.* the Outward.
ff. the *Acetabulum*, or *Socket*, for receiving the Head of the Thigh Bone.
g g. the *Os Ilium*. *h h.* the *Vertebra* of the *Os Sacrum*. *i i.* the *Os Ischii*, or *Coxendicis*.

Fig. 262. The Fore side of the Thigh Bone of the Fore Leg. *a.* the Head Fig. 262.
of the Thigh Bone, where it is fastened to the *Scapula*. *b.* a large rough Spine, which runs above half the length of this Thigh Bone. *c.* a Protuberance of this Bone on the outside. *d.* a large Foramen, or Hollow Passage. *e.* a Sinus for Receiving the Head of the Tibia. *f g.* the Basis, or lower Extream of the Thigh Bone.

Fig. 263. The Stomach, and Guts. *A* the Gula. *B B.* the Stomach. *c.* A Fig. 263.
Perforation of the Stomach caused by an Ulcer there. *d d.* the two Pouchings out of the Stomach at the two Ends. *e.* the Pylorus. *f.* the beginning of the Duodenum. *g b i K L M N o p q.* Represent the small Guts, and the Coyles and Covolutions they do make; some of the Coyles lie hid, and out of Sight: But the Order how they follow one another is signified by the Order of the Letters of the Alphabet; so that *g.* follows *f.* and *g.* is succeeded by *i.* and *i.* by *K.* and so on to *q.* where the *Ilion* is Discharged and Emptied into the *Cacum*, or, if that is full, into the *Colon*, at the first Letter *S. R. R.* the *Cacum*. *S S S.* the *Colon*. *T.* the *Rectum*. *V.* the first *Mesenterie* or *Mesenterium minorum Intestinatorum*. *w.* the second *Mesenterie*; or *Mesenterium Majorum Intestinatorum*.

Fig. 264 The Urinary, and Uterine Parts. *A A.* the two Kidneys. *bb.* the Fig. 264.
Emulgent Veins. *c c.* the Emulgent Arteries. *d d.* the Glandulae Renales. *e e.* the two Ureters. *f.* the Insertion of the Left Ureter into the Neck of the Bladder. *G.* the Bladder of Urine, turn'd aside. *h.* the Urethra. *i i.* the two Vaginae Uteri. *K.* the common Passage from the Urethra, and the two Vaginae. *l.* the Arteria Aorta, or Great Arterie. *m.* the Vena Cava. *n n n.* the Spermatick Arteries. *o o o o.* the Spermatick Veins. *p p p.* the Hypogastrick Arteries and Veins. *r r r.* the Ala Uteri, seu potius Cornuum. *S S.* the Ovaria. *t t.* the Tuba Fallopiana. *u u.* the Cornu Uteri of the Left side opened. *w.* the Cornu Uteri of the Right side not opened. *x x.* the two Uteri opened. *y.* the Diaphragm that divides the two Uteri. *z z.* the Imperfect Diaphragm which partly divides each Uterus, and lies over the Passage of that part of the Uterus, which is doubled and tends to the Vagina.

Fig. 265. The Uterine Parts more particularly. *A A.* the two Ovaria. *bb.* Fig. 265.
the Fimbria Foliacea. *c c.* the Tuba Fallopiana. *d d.* the two Cornua Uteri. *EE.* the two Uteri Reduplicated. *f.* a Slit in the Neck of the Left Uterus to shew its Passage into the Vagina on that side. *g.* the Left Vagina opened. *h.* the Osium, or Mouth, of the Right Vagina. *i.* the Common Passage from the Urethra and Vagina. *K.* the Urethra. *ll.* the Bladder of Urine cut off.

Fig. 266. The Hairy Tophus.

Vol. II.

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Fig. 267. Fig. 267. The Liver. *A.* the Vena Cava. *BBB.* the 3 Lobes of the Liver. *C.* the Bladder of Gall. *ddd.* the Fissures in the Body of the Liver. *eee.* the Incisures at the Edges of the Liver.

Fig. 268. Fig. 268. *A.* the Spine of the 2d Vertebra of the Neck. *b.* Represents its Thickness. *c.* a large Sinus for the receiving the first Vertebra. *d.* the Dens or Tooth of this Vertebra. *e.* the Processus Obliquus Superior of one Side. *f.* the Processus Obliquus Inferior of the same Side.

Fig. 269. Fig. 269. *A.* the Spine of the 3d Vertebra of the Neck, where is shewn its natural Thickness. *b.* the Hole through which the Medulla Spinalis Passes. *c c.* two small Foramina for the Passage of the Vessels. *d.* Represents the Cleft at the top of the Spine. *ee.* the two Processus Obliqui Superiores before. *ff.* the two Processus Obliqui Inferiores before.

Fig. 270. Fig. 270. The first Vertebra of the Thorax. *A.* the Spine, which is long and Acute. *bb.* the Oblique Processes before. *cc.* the Oblique Processes behind. *dd.* the Transverse Processes. *ee.* where the Ribs are fastened. *f.* the Hollow where the Medulla Spinalis passes

Fig. 271. Fig. 271. The 4th Vertebra of the Loins. *aa.* the two upper Oblique Processes behind. *b.* the Spine. *cc.* the two under Oblique Processes behind.

Fig. 272. Fig. 272. The 2d and 3d Vertebrae of the Tail. *aa.* two Vertebrae of the Tail. *bbb.* the Spines, or Hooks on the inside, by means of which it can better hang by its Tail. *cc.* A Hollow, or Foramen, in the middle of these Spines, through which Blood Vessels Pass.

A Monstrous
double Tur-
key; by Sir
J. Floyer.
n.259-P.434.

CX. At Thorpe in Staffordshire, two Young Turkeys, were taken out of an Egg (of the Ordinary Size) when the rest of the Eggs were well hatched, which Grew together by the Flesh of the Breast Bone, but were in all other Parts Distinct. They seemed less than the ordinary thickness of Turkeys: For there wanted both Nutriment and Room for their Growth; which was the occasion of their Cohesion and Smallness. They had Distinct Cavities in their Bodies, and two Hearts: so that they had two Distinct Cicatricula's, and Consequently the Egg had two Telks in it, from whence they were produced; which Accident is very Common. But I have a dried Monstrous Chicken which had but one Head, 4 Wings, 4 Legs, and one Cavity in the Body, and consequently had but one Heart. In this Case this Monstrous Chicken was produced from one Cicatricula. So Paræus mentions a Double Infant with one Heart. In these Cases the Original of the Infant was one, and the Vessels Regular; but in the Extremity the Arteries and Nerves were divided into more Branches than Ordinary, and produced Double Parts. And this is like the double Flowers of Plants, which are produced so by the Richness of the Soil. And thus it is in the Eggs of Quadrupeds; they are Joyned in the Ovarium, and as they Grow their Bodies do externally Cohere. So that I may Observe, that there are these two Reasons of the Multitude of the Parts in an Embryo; the Joyning of two Perfect Animals, or else the Extraordinary Division of the Original Vessels, the Arteries and Nerves.

CXI. The Body of this Colt appeared to the Eye Compleatly Formed, without any *Monstrosity* to be taken Notice of in it: But the *Head* being opened, and examin'd, it was found, that it had no Sign of any Nose in the usual Place. The two Eyes were united into one double Eye, which was placed just in the middle of the *Brow*, the Nose being wanting which should have separated them: Whereby the two Eye Holes in the Skull were united into one very large round Hole, into the midst of which, from the *Brain*, entered one pretty large *Optick Nerve*, at the End of which grew a great *Double Eye*; that is, that *Membrane*, called *Sclerotis*, which contained both, was one and the same, but seemed to have a Seam, by which they were joined, to go quite round it, and the *Fore* or *Pellicid Part* was distinctly separated into two *Cornea's*, by a *White Seam* that divided them. Each *Cornea* seem'd to have it's *Iris*, (or *Rainbow-like Circle*) and *Apertures*, or *Pupills*, *Distinct*, and upon opening the *Cornea* there were found within it two *Balls*, or *Crystalline Humours*, very well shaped. The *Eye Lids* were also a little divided in the middle. Just above the Eyes, as it were in the midst of the *Fore-head*, was a very deep *Depression*, and out of the midst of that grew a kind of *Double Purse* or *Bag*, containing little or nothing in it: But to some it seemed to be a *Production* of the matter Designed for the Nose, but diverted by this *Monstrous Conception*; perhaps the *Processus Mammillares* Joyned into one, and were covered with a thin *Hairy Skin*.

A Mon-
strous Colt;
By Mr. R.
Boyle, n. 5.
p. 85.

Fig. 273.

CXII. A Butcher (at *Limmington* in *Hampshire*) having killed a fatted Cow, and opening the *Womb*, found in it a *Monstrous Calf*, which begun to have Hair. The Feet of this Calf were so parted, as to be like the *Claws* of a Dog; the *Legs* had no *Joints*; and the *Tongue* was, *Cerberus-like*, *Tripple*, to each side of his Mouth one, and one in the midst. Between the fore Legs and the hinder Legs was a great Stone, on which the Calf rid. The Skin of the Breast, and between the Legs, and of the Neck (which parts lay on the smaller End of the Stone) was much thicker than on any other Part. The Stone (which was bigger at one End than the other) Weighed $20\frac{1}{2}$ Pounds, the outside was of a *Greenish Colour*; and not Plain, but full of little Cavities; when broke it appeared full of small *Pebble Stones*, of an *Oval Figure*; its Colour *Gray* like *Freestone*, but intermixt with *Veins* of *Yellow* and *Black*.

A Monstrous
Calf; By Mr.
Dav. Tho.
mas. n. 1. p.
10. n. 2. p. 20.

CXIII. Jan. 11. 1677. A Cow of Mr. Will. Dab's, at *Milnecoat* in *Warwickshire*, brought forth a *Monstrous Calf*; having one perfect large *Head*, and on the right Side of that grew another, almost as large, and of true Shape, having both *Tongue* and *Teeth*; and from the *Roof* of the Mouth of the *Monstrous Head* hung down a piece of *Flesh* with the shape of a *Tongue* upon it, and a row of *Teeth*, as on an under *Jaw*: Which occasioned the Man who shewed it, to say that it had 3 Mouths. It had to each Head 2 Eyes, only those of the *Monstrous* were very small, and I believe had no Sight. It had only 2 Ears to both Heads, one of which was placed on the *Far-*

A Monstrous
Calf with 2
Heads; By
Sir Rob.
Southwel.
n. 238. p. 79.

side of the Monstrous Head, the other as usual in other Calves. It Breathed equally at both Mouths, and had Communicated with the same Throat, but took its Nourishment only at the Perfect Mouth, the under Jaw of the other being so Weak, that the Mouth always stood open and drivell'd. It appeared on the left side to be a perfect Calf, and looked very lively, and was at 3 Days Old, as large and strong as other Calves usually are at 10 Days, or a Fortnight.

Two Mon-
strous
Lambs, by
Mr. Cole-
press, n. 26.
p. 480.

CXIV. Feb. 24. 166⁶. Rob. Cloak, of Beer Ferris in Devonshire, had a Black Ramb-Lamb fallen with one Head, but two Distinct Bodies, with 8 Legs, which Bodies were joined in the Neck. It had two Eyes and as many Ears, in the usual Places; and one Extraordinary Eye in the Niddock, with one single Ear, about an Inch distant from the Eye backwards. Its Dam usually brought forth two Lambs every Year, as she did this Year also; which with the Ewe remains Alive; but this Monster was found Dead by the Hedge.

About the same time, John Cauce, of the same Parish, had a White Lamb fallen, with two Distinct Heads and Necks, joined at the Shoulders, but one only Body; and that well formed, yet having Double Entrails in all Respects. The Ewe remains Well, but the Monster Dy'd.

A Monstrous
Pig. By ...
n 147. p. 188.

CXV. In December 1682. Among many Pigs of a Sow, there was one which had no Passage for the Faces, either Solid or Liquid, although the Anus was not outwardly closed up; and being dissected, we found the Guts very much Distended and Transparent, and through them appeared the Faces very Liquid, accompanied with no small quantity of Wind. The End of the Rectum was entirely closed like a Bladder, and Sealed as it were, Hermetically, Pendulous in the Cavity, and not in the least continued to a Sphincter, of which there was no Sign. There was no Bladder to be found, nor Uterus, nor any Mark of what Sex it was designed for: But both the Ureters were inserted into the Rectum, within an Inch, or thereabouts of the End. The Stomach was full, even to Distension, of an Hard Substance, which appeared exactly the same with hard press'd Curds. The Chyle came freely enough out of the Ductus Peequelitanus, where it was inserted into the Jugular, upon the pressure of the Intestines: But I could not Urge the Liquid or Flatulent Contents of the Guts upwards, within two Inches of the Pylorus, tho' I pressed them till they Brake.

Two Mon-
strous Pigs
by Sir J.
Floyer, n.
259. p. 431.

CXVI. In May 1699. There was shewed to me a Pig at Weeford in Staffordshire, with a Face something Representing that of a Man's, and the Chin was very like that of an Humane Fetus. But, when I had well considered the Head, I observed there was a Depression of the Bones of the Nose, in that Place which was betwixt the Eyes, in which the Pig's Face seemed to me to be Broken, and the Nose drawn up to appear like an Humane. The under Jaw was Inverted, to grow up to meet the upper; the Tongue and Mouth were made more like an Humane, being altered by some External Pressure upon the Mouth of the Pig, which broke the Bones of

of the Nose, and caused their Depression towards the *Palate*, and the *Inversion* of the *under Jaw*. This *Pressure* on the Mouth forced the *Bones* upward, so much as to cover the *Eye Holes*, and the Pig appears Blind. *A.* is the Place of the *Bone Depressed*; *B.* is the Depth of it. It closed it self with a Spring, when we opened it by Force; so that it had Grown closed up, ever since it was *Cartilaginous*. By this Breach, or Depression of the Pig's Face, I was first Convinced, that this Monster was not produced by the *Copulation* of two *Species*, as was usually apprehended, but only occasioned by the Perversion of the Compression of the *Womb*, or *Placenta*, or other Pigs in the same Part of the *Womb*. And that the Pig's Head was streightened in its Growth, appeared by the Flatness of the Ears, and that this Depression happen'd whilst the *Bones* were *Cartilaginous*, appears by the Bones depressed, which remain'd *Cartilaginous*, and at the same time the under *Jaw* was Inverted, and the Head made more Round. I farther observed, that all the Head was covered with Hair, as the other Pig's were; that the *Teeth* in the Mouth were Pig's *Teeth*; the Hair of the Pig's Head was Yellow, as that of the Sow's was; the Monstrous Pig was as big, and as well Grown as the rest of the Pigs, and therefore begot by the *Boar* at the same Time; the Nose was a Perfect Pig's Snout, and there was no upper Lip, as in the Human Kind. In all the other Parts, it appeared to be a Perfect Pig; no Parts were wanting, but those of the Face, distorted by some External Accident. At the beginning of the 17th Week, from that Time when the Sow took the *Boar* which is the usual Time the Sow Pigg'd 8 Pigs, the first 5 were Perfect Pigs, the Sixth was the Monster, and after that two more Perfect Pigs. This Monster was Pigg'd Alive, but dyed because it could not Suck, the Nose being Stopped, The Cry of the Pig was not like the other Pigs, because of the Stoppage of its Nose, and the Alteration of the Figure of its Mouth.

This Kind of Monstrous Pigs, produced by the Unnatural Situation of Parts, by some External Compression, I believe is very frequent; because I had another of the same kind, sent me out of *Derbyshire*, which had a Resemblance of a Man's Face, and all the other Parts of a Pig, and this had the same Chin, and Depression betwixt the Eyes, the Roundness of the Head, and Flatness of the Ears, I have above described. But this *Derbyshire* Monster wanted Hair, as Pigs which come too soon do; and no Sex could be distinguished in it: But the former described was a *Boar Pig*.

CXVII. This Monstrous Carling was Dead when I met with it, and I am perswaded that it was so brought forth, the Lungs being Compact and free from Air, which they could not be, if it had ever Inspired. It was Double from the Navel downwards, having 4 Hind feet, 2 Tails, 2 Anus's, and 2 Pudenda; for they were Females. They were Jointed into one Trunk at the Navel, and were continued so upwards: But yet this Monster had 2 Pair of Fore-feet, one of them on the Back, and the other on the Breast. The Head, though single, had two Pair of Ears, one naturally Seated, and another at the hinder part of the Head, between the *Processus Mammillares*, to which the *Vertebra* of both the Necks were Jointed. There

The Anatomy
of a Mon-
strous Double
Cat; By Dr.
Mullen. n.
174. p. 1135.

Fig. 275.

There was only one Stomach under the Liver in the Right side, reaching under another Liver in the left. The Guts were single till within 6 or 7 Inches of the *Anus*, and there was a Division into two Branches, one going to each *Fundament* below the Division there were plainly to be seen two *Cacums*, within about 3 Inches of the *Anus* each. There were two Livers, one much smaller than the other, that which was in the Right side was the least, the other lay lower down in the left side, they were both entire without any Division or *Lobes*. There was a *Vena Umbilicalis* inserted into each of them. There were two *Arteries* inserted into the Liver in the left side, both coming from the *Aorta*, and these I shall call the *Cœliaca*; but there was only one inserted into the Liver placed in the right side. There was no *Vena Cava* below the Livers, for all the Veins coming from the lower parts entered the Livers as the *Vena Porta* does naturally. There was a Branch of a Vein on each side proceeding from the Loins inserted into the Back Parts of the Liver: And besides these there was not a Branch to be seen, but what was inserted into the middle of the Livers. There were two *Kidneys* on each side furnished with *Ureters*. There was neither *Spleen* nor *Pancreas* in either side.

There was a *Double Diaphragm* meeting in the middle between the two Back Bones, and making a *Membrane*, which to me seemed to be a *Mediastinum*, for it reached up to the *Thymus*. There were 2 Hearts in it, one placed above the other, and a little to the Right side, it was much higher than ordinary, and it had a Vein coming to it from the little Liver in the Right side, which (together with 3 other small Veins, one from each of the *Fore Feet*, and one from the Head) furnished this Heart with what Blood was to be Circulated by it. It had only one *Auricle*, and one *Ventricle*: So that it seemed to be but half a Heart. There was a pretty large Passage into the *Arteria Aorta*, the Contrivance of which was very singular; for above this Heart it was made like an Arch of a Circle, into which there was a direct Passage from the Heart for the Blood. When I further Examined this *Artery*, I found that it went down on each side on the *Vertebra* of the Backs between the *Kidneys*, and divided it self on each side after the usual manner, after it had lent each *Kidney* a Branch, the Liver in the Right side one, and the Liver in the Left side two. Below the former, a little towards the Left side of it, there was another half Heart, having only one *Auricle* and one *Ventricle* like the former. This received a little Blood but what was transmitted from the large Liver in the Left side, by that that is call'd the *Truncus Ascendens* of the *Vena Cava*. The *Artery* carrying the Blood from this Heart was inserted into the *Artery* lately describ'd, as well as that of the other Heart. So that, if the Blood Circulated through either of them, the whole Animal must necessarily be supplied with Blood, a Contrivance not unlike that of the *Arteries* under the Brain, where the *Arteria Carotides* and *Vertebrales* do Empty themselves into one Common Channel, from which all Parts of the Brain may easily be supplied with Blood.

The Head was Joyned to two Necks about the *Processus Mammillares*.

There were 4 Orders of *Ribs*, though the Body was but one above the

Navel.

Fig. 275. Expresses to the Life the outward Shape, when placed on its Back.

Fig. 276. The Cat Opened. 1. the *Stomach*, pull'd from behind both the *Livers*, so as to be plainly seen. 2. the beginning of the *Guts* below the *Pylorus*. 3. The Division of the Gut into two Branches, whereof one went to each *Anus*. 4. 4. the *Two Cacums*. 5. 5. 5. 5. the *Two Pair of Kidneys*, furnished with *Emulgent Arteries* and *Veins*. 6. A large *Liver* in the Left side, much lower situated than the *Liver* in the Right side. 7. the *Liver* in the Right side, with a *Vein*, 8. coming from the *Kidneys* of the same Side, after it had United above the *Emulgents*; this supplies the Office of the *Vena Cava* and *Vena Porta*. 9. 9. two large Branches of the big *Artery* going into the Body of the big *Liver*. 10. 10. 10. 10. the great *Artery*, supplying both sides with Blood, and receiving of it from the two *Hearts*. 11. The *Vein*, bringing the Blood from the lower Parts of the Left side into the *Liver*, 6. of the same side. 12. 12. the big *Artery*, sending Branches to each of the *Kidneys*. 13. the upper *Heart*. 14. the *Artery* that supplied the Head with Blood. 15. 15. the *Axillary Arteries*. 16. the *Vena Cava* coming from the *Liver* in the Right side to the Heart. 13. 17. the Passage from the said Heart to the *Aorta*.

Fig. 277. 1. The *Liver* in the Left side, freed from all things that kept it any way out of Sight. 2. the *Vena Cava* passing from it to the lower Heart. 6. 3. A Skirt of the *Diaphragm* turned to the Left side, that the former *Vein* should better appear. 4. the *Stomach*, displaced for the former Reason. 5. 5. 5. 5. the *Kidneys*. 6. the lower *Heart*, in its due Situation. 7. the upper *Heart*, drawn out of its place upwards, that the other, 6. with the Passage 11. from it to the *Aorta*, 9. 9. might be well Represented. 8. 8. the *Liver* in the Right Side, doubled and turn'd over the *Heart*, 6. that it might be the better set forth. 9. 9. 9. the *Aorta*, where it is not hid by the Parts display'd for the former Reason. 10. the *Lungs* not well Represented. 11. the Passage from the lower *Heart* into the *Aorta*.

Fig. 278. The Skull opened, and freed from the Brain. 1. 1. the Hollows, through which the *Medulla Oblongata* was continued to the *Medulla Spinalis*.

2. 2. the two Necks.

Fig. 279. 1. 1. The *Two Diaphragms* separated from the *Cartilages* of the *Ribs*, that their *Junctures* may be seen. 2. 2. 2. 2. The *Vertebra* of both the Backs. 3. 3. 3. 3. 3. 3. the *Juncture* of the two Sets of *Ribs* that were at the Back. 4. 4. 4. 4. the two Sets of *Ribs* that were joyned to the Breast. 5. the Tips of the *Diaphragms*, pull'd downwards to shew the *Ribs* plainly. 6. 6. the *Vertebra* of the two Necks.

Fig. 278.

Fig. 279.

Explication
of the Fi-
gures.

Fig. 275.

Fig. 276.

Fig. 277.

Fig. 278.

Fig. 279.

An Animal
resembling a
Whelp void-
ed per Anum
by a Male
Greyhound;
By Mr. Edm.
Halley. n.
222. p. 316.

CXVIII. The Account you had from *Chester*, in 1695. of a *Greyhound Dog* that voided an Animal, Resembling a *Whelp*, *per Anum*, as strange and incredible as it may seem, is yet here stedfastly believed; and the Creature was kept for some time in *Spirit of Wine*, having Lived for some short time after it came into the World, and it was seen alive by Mr. *Roberts* of the *Society*, then in *Chester*. They say, it exactly resembled a *Grey-bound-Whelp*, and had on its side a large Spot, in the same Place, as the *Dog* it proceeded from, had such another; and that with it was Voided a Whitish Mucous Matter, so that the People here at *Chester* will not permit me to Question the Truth thereof.

A Bitch with
Puppy, tho'
she had lost
the Spleen;
By
n. 105. p. 117.

CXIX. 'Tis Notorious all over *London*, that divers Years since, a *Bitch*, yet Alive, of a considerable *Noble-man*, after she had lost her Spleen, hath been several times with *Puppies*; of which some out of Curiosity were opened, and found to have a very *Fair Spleen*. *Vid.* *Diemerbroeck de Anat. Corp. Hum.*

A Cow with
Four Calves;
By Sir J.
Floyer. n.
259. p. 435.

CXX. I am informed, that this Year 1699 at *Dunchurch* in *Warwickshire*, a *Cow* Calved *Four Calves*, Perfect and all Living.

A Hen with
a Perfect
Chick in the
Ovarium;
By n.

CXXI. About 2 or 3 Years since, there was a *Hen* at *Wackton* in *North-folk* which being big with *Eggs*, upon some account could not Lay, but after a time dyed; and then being opened, there was found in the *Ovarium* a *Perfect Chick*.

An Egg
found within
another Egg;
By n.
50. p. 1019.
230. p. 632.

CXXII. In *France* a Small Egg of about 7 Lines from End to End, and $4\frac{1}{2}$ of bigness, was found Included in a *Hen's Egg*, which appeared to have nothing Extraordinary on its outside. The *Small Egg Shell* was fastened to the Shell of the greater by one of its Extremities.

Ova found in
a Cow; By ...
n. 74. p. 2218.

CXXIII. There hath been very lately made, by two Physicians at *Paris*, a Dissection of a *Cow*, in *cujus Testiculis Ova reperta fuerint, uti Kerkringius observasse se scripserat, in Anthropogeniæ Ichnographia.*

The Ova,
after a 2d.
Conception,
dispersed in
the Abdomen
of a Bitch,
tho' the Cor-
nua Uteri
were filled
with the
Bones and
Flesh of a
Former Con-
ception; By...
n. 147. p. 183.

CXXIV. The Sagacious *Harvey*, after many repeated Dissections of *Im-pregnated Deer*, asserts, that nothing for about 6 or 7 Weeks can be seen in the *Horns* of their *Wombs*; that then there appeared somewhat like an *Egg*, a Transparent Liquor included in a very thin *Membrane*, in which after a Week he could plainly see the *Rudiments* of a *Fætus*. He is well satisfy'd (after several Tryals) that no Liquor can be so forcibly injected into the *Womb*, as to make its Passage into the Place of *Conception*: Nor would he suspect that the *Seed* of the *Female* lay till the *Egg* appear'd, in any *Crannies* or *Recesses* of the *Horns*; which he asserts are then as *Imoorn* and soft, as the *Corpus Callosum* of the *Brain*. After Dr. *Harvey* had thus sufficiently confuted the

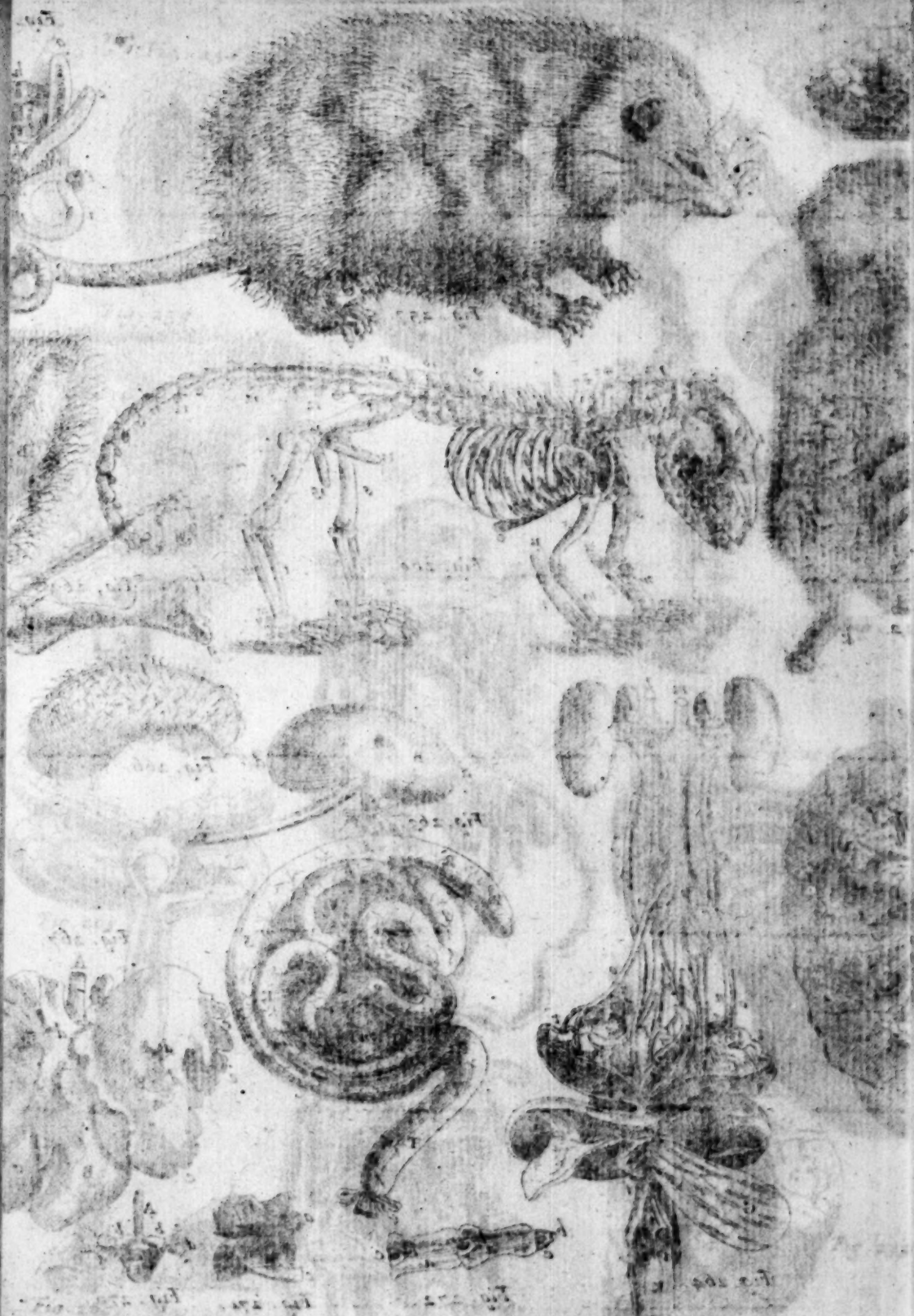


Plate 13. Vol. 2. Fig. 904.

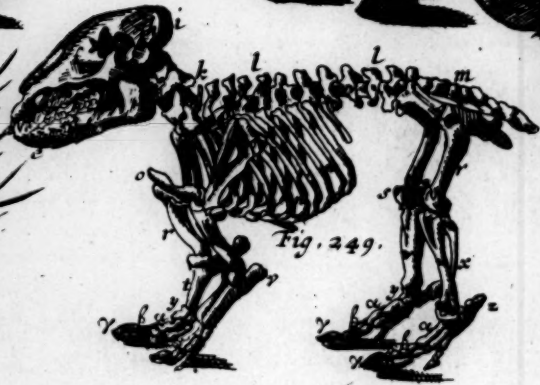
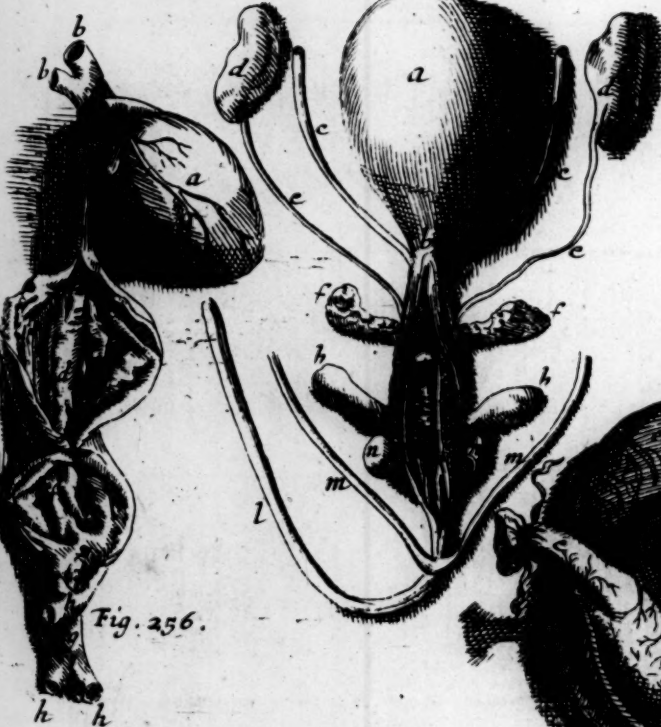
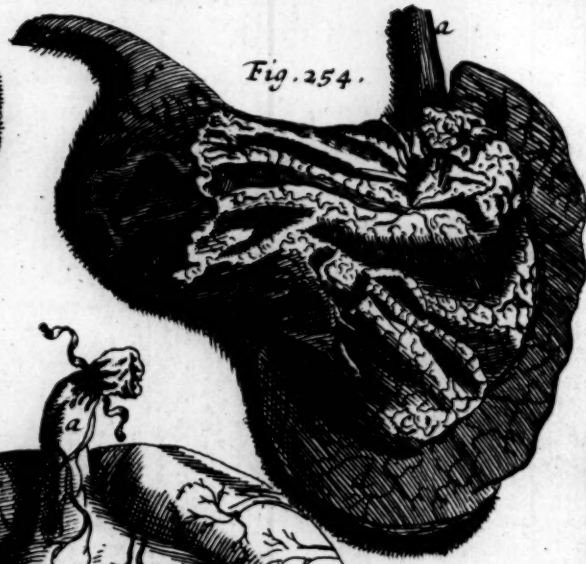


Fig. 255.



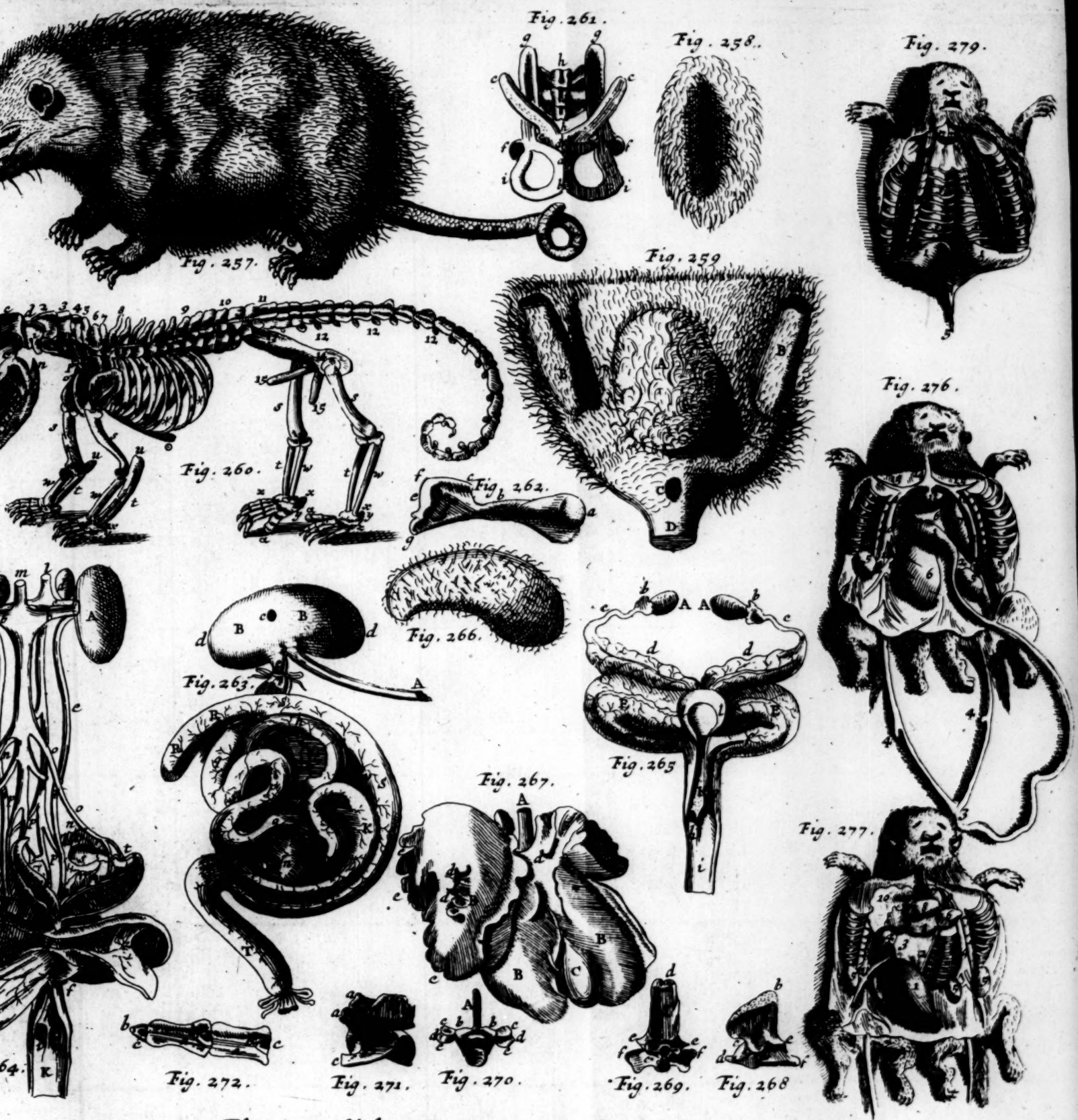


Fig. 273.





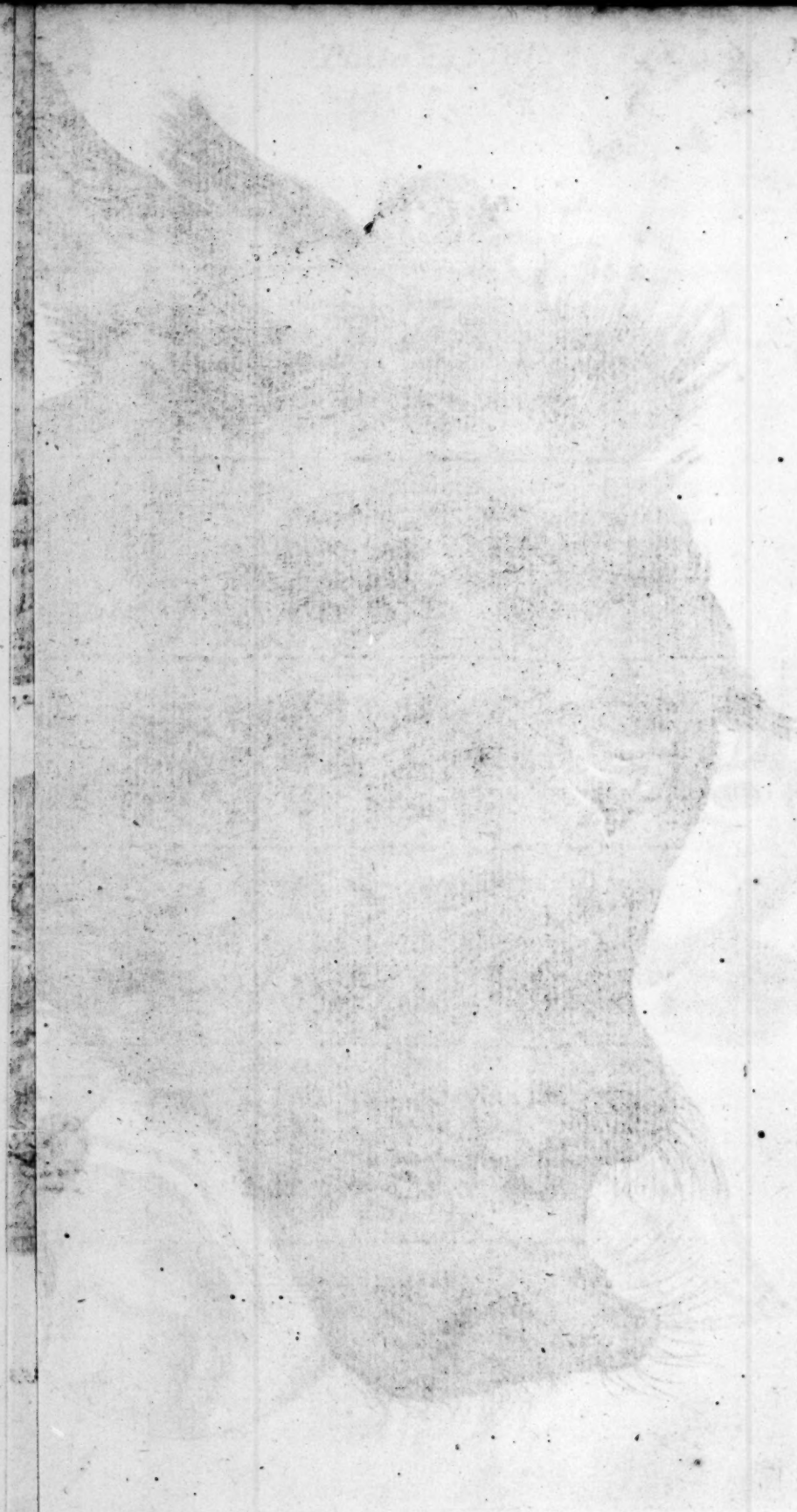
Fig. 275.



Fig. 278.



Fig. 274.



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nion of the *Production of Animals* from the Mixture of the seminal Matter of both Sexes, 'twas not so difficult to discover whence the Egg came, which he saw about 7 Weeks after Impregnation. The *fallopian Tubes*, which joyn to the Horns, and terminate very near the *Ovaria*, (as the *Testes muliebres*, are generally now call'd) directed the ingenious and industrious *De Graaff*, to make more accurate Dissections of them: And he has so very nicely observ'd the Progress of the Eggs in *Conies*, the very time of their passing into the Tubes, and appearing in the Horns of the Womb, (which comes very near that proportion of Time *Dr. Harvey* observed the Eggs in his Deer) that the Opinion of the Production of all Animals from Eggs is now almost universally received.

Some time since indeed, the learned *Diemerbroeck*, and very lately *Mr. Verney*, have endeavoured to confute this Opinion, and expose it. The most considerable Argument they use, is taken from the Narrowness of the *Fallopian Tubes*, where they open into the Womb, and at their Extremities. But *Dr. De Graaff* prevented this Objection, by alledging, that the Hole by which it has its Exit out of the *Ovarium* is as narrow; that no Force is used to open it, but it expands it self as the *Os Uteri* before the Birth: As Nuts and Peach-stones, &c. give way to *Germinating Plant*, which is less able to make its Way than the Egg. But besides which, these Authors urge, tho' the Extremity of the Tube be membranous in most Quadrupeds, in which it's possible a seminal Liquor might be transmitted into the Womb; in Women it's divided like a Knot of Ribbon, and is no more adapted to receive any thing but an Egg, than the Fingers expanded to receive and contain a Fluid. The Egg has not been able sometimes to get into the Womb; *Riolanus* speaks of a human *Fætus* seen in one of the Tubes, and *Dr. Harvey* assures you he has seen it himself.

Vid. Inf. Vol.
III. Cap. 4.
§. CVIII.
&c.

In the Dissection of a *Bitch* at *Oxford*, it was observ'd, that the *Embryo's* either could not get into the *Womb*, the membranous *Expansion* being hindered from ascending to and clipping the *Ovaria*, by the Fulness of the *Womb*, or from the same Cause were forc'd back again. She had been with Whelps; by a Blow she received the *Fætus's* died within her. She discharged by the *Pudendum* a great Quantity of putrid Flesh and Matter. She was afterward able to run in the *Pack*. After the 2d Impregnation she was observed to have a very ill shaped Belly; when dead, the Owner, a Person of Quality, sent her to *Oxford*. The Horns of the *Womb* were so stuff'd up with the Bones and firmer Muscles, and thicker *Skin* of the *Fætus's*, (some of them lay in the usual posture, the *Skeletons* of which were entire, the Interstices of the Bones only fill'd up with *Skin* and *Flesh*) that no seminal Matter, or *Aura seminalis* could possibly find a passage to the *Ovarium*. The Eggs affected in the 2d Impregnation, finding no Room in the *Horns*, were forc'd back into the *Abdomen*; where they were found affixt to the *Mesentery*, *Kidney*, &c. Only two of the Bags had a Communication with the *Womb* by a slender Duct. These I suppose fell into the *Horns* first, and began to fasten to them, but growing larger were forc'd to retire. The other three had no Reception there at all. The Membranes which contained the *Embryo's*

were all of them very thin, and the *Animalcules* in them had wanted a due Supply of *Nutritious Matter*. This seems to give as clear a Proof of the Truth of the modern *Opinion*, as can be expected or desired.

But if *Anatomy* had not discovered Eggs, and demonstrated their Use and Progress to the Womb, it would be very difficult to conceive how an *Animal* could be produced from the Mixture of the *seminal Liquors* of both Sexes. Every *Animal* (tho' upon other Accounts esteemed the most despicable) is made up of so many different Parts, and those of so excellent a Contrivance, and so wonderful a Respect to one another, that 'tis not to be imagined, that the *Seminal Fluids* lying loose, and at large in the Capacity of the *Womb*, and exposed to so many Accidents, could give a Production so admirable. Every Jog of it from the frequent Motions of the Female would disturb and distract the present Designs of the *Plaslick Power* they speak of. The Humours and Vapours which have a Passage to, and humect all the Parts of the Body, would in the *Womb* break in on the soft *Seminal Mass*, and break off the tender Filaments when first a Forming. In Quadrupeds the *peristaltick Motion* of the Horns would perpetually separate the Parts of the seminal Collection, and scatter those Pieces, which Nature is putting carefully together into the Fabrick of an Animal. From this Way of Conception, Monsters would be very frequently brought forth, and would be much less wondred at, than a perfect Production is now. We see how very industrious Nature is in preserving the Species of Vegetables. When the tender Seed is first Formed, it is secured from external Injuries by various sorts of Cases. The *Embryo* of the Plant contained in the Seed hath 3 or 4 Coats to enclose it; the outermost is designed of sufficient Strength to preserve it. None of the *Juices* of the Earth are permitted to enter in, but such as are fit to put into Motion, or supply the Liquor contained in the inner Membrane, from whence it has its first Increase. And, as the Eggs of Animals are designed for the same Purpose the seeds of Vegetables are, so there is very great Agreeableness between them. The Shells and Membranes of Eggs (except those which are brought to *Perfection* in the Female Sex) are very like those of *Seeds*; both have a *Colliquamentum* or more fine and spirituous Liquor, which is first to be spent before those which are grosser can be received in the extremely fine and small Pores of the Foetus, when only just begun to be formed; and in both the Parts of the *Embryo* are designed and drawn out, before the Egg has been at all affected by the *Masculine Seed*, or the *Vegetable Seed* put into the Womb of the Earth. The Figure of the Plant may be seen in the larger Seeds, and Miniature of a *Chick* in the spot of the Yelk.

But, if so great and so various an Artifice is necessary to raise a Plant, shall Nature be thought less careful and industrious in the *Propagation* of Animals, whose Parts are more numerous, and of a much finer Texture? And, since those Animals and Vegetables are by some allowed to take their Original from Eggs and Seeds, whose Largeness will permit them to observe them, it seems an Opinion with too much *Precipitancy* taken up, that sup-

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poses some of the greater *Animals*, and the least of these, and *Plants*, are supplied from equivocal Generation ; that corrupted matter from the warmth of the Air, or the motions of its own Principles, can form the Parts of the one or the other. For the Heat of the Air endeavours to dissipate and remove the thinner Parts from the more gross : Since no *Membrane* is supposed to confine them. And the more active Principles are from their own Nature always struggling to be quit of them. And this way the parts of an *Animal* would be sooner broken into pieces, than a new one generated.

But they believe it may be allowed, that the least and most inconsiderable *Animals* and *Plants* are this way Formed. But their Minuteness makes the Difficulty greater : A *Membrane* to include the Conception with its first Nourishment seems more necessary here, where the Parts are more delicately put together, and from their exceeding Fineness, might more easily miscarry. But if after this Method some *Animals* and *Plants* can be produced. why is the same Species and these very Individuals they suppose so made, furnished with Organs for Univocal Generation ? If *Slime* and *Mud* can afford *Frogs* and *Eels*, why does the first *Spawn* so many *Eggs*, and are the other Viviparous ? Why does not so great a Diversity of putrid Parts in the Earth, differently affected by unaccountable Accidents, often present us with new Living-Creatures, and Vegetables of peculiar Species ? But no such new *Plants* are taken Notice of, and the *Mites* are of the same sort from Cheese and from Meal. The Objection which is offered against *Epicurus* will be made with the same Force against this Opinion : If the Earth at first equivocally produc'd Men, Quadrupeds, Birds, and Fish, why has it not done it very frequently, or, at least, some Times since ? We begin to suspect the Cheat, when the Artist is not able to perform the same again.

CXXV. 1. Upon comparing the Observations and Discoveries of Dr. Harvey, S. Malpighi, Dr. de Graaff, and M. Leewenhoek, with one another, these three things seem to me very probable. 1. That *Animals* are *ex Animalculo*. 2. That the *Animalcules* are originally in *Semine Marium* & non in *Fæminis*. 3. That they can never come forward, nor be formed into *Animals* of the respective Kind, without the *Ova in Fæminis*.

The modern Theory of Generation. by Dr. Geo. Garden. n. 192. p.474.

The first of these seems probable from these 3 Observations ; 1. That some such thing has been so often observed by *Malpighius* in the *Cicatricula* of an Egg before *Incubation*, as the Rudiments of an *Animal* in the Shape of a Tadpole, as may be seen in his first, and in his repeated Observations, *de Formatione Pulli in Ovo*. 2. The sudden Appearance and Displaying of all the Parts, after *Incubation*, makes it probable, that they are not then actually formed out of a Fluid, but that the *Stamina* of them have been formerly there existent, and are now expanded. The first Part of the *Chick* which is discovered with the naked Eye is, you know, the *Punctum Saliens*, and that not till three Days and Nights of *Incubation* be past ; and then

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on the fifth Day the Rudiments of the Head and Body do appear. This made Dr. *Harvey* conclude, that the Blood had a Being before any other Part of the Body, and that from it all the Organs of the *Fœtus* were both formed and nourished; but by *Malpighius's* Observations we find, that the Parts are then only so far extended as to be made visible to the naked Eye, and that they were actually existent before, and discernable by Glasses. After an Incubation of 30 Hours, are to be seen the Head, the Eyes, and the *Carina*, with the *Vertebra*, distinct, and the Heart. After 40 Hours its Pulse is visible, and all the other Parts more distinct, which cannot be discerned by the naked Eye before the Beginning of the fifth Day; from whence it seems very probable, that even the so early Discovery of those Parts of the *Fœtus* by the *Microscope*, is not the discerning of Parts newly formed, but only more Dilated and Extended by receiving of Nutriment from the *Colliquamentum*; so that they seem all to have been actually existent before the Incubation of the Hen. And what *Swammerdam* has discovered in the Transmutation of *Insects*, gives no small Light to this, whilst he makes appear in the Explanation in the 13th Table of the *General History of Insects*, that in those large *Eruca's* which feed upon *Cabbage*, if they be taken about the time they retire to be transformed into *Aurelias*, and plunged often in warm Water, to make a Rupture of the outer Skin, you will discern through the Transparency of their second Membrane, all the parts of the *Butter-fly*, the *Trunk*, *Wings*, *Feelers*, &c. folded up: But, that after the *Eruca* is changed into an *Aurelia*, none of these parts can be discerned, they are so drenched with Moisture, though they be there actually formed.

Another Consideration is from the *Analogy*, which we may suppose, between *Plants* and *Animals*. All *Vegetables* we see, do proceed *ex Plantula*, the Seeds of *Vegetables* being nothing else but little *Plants* of the same Kind folded up in Coats and Membranes; and from hence we may probably conjecture, that so curiously an Organized Creature as an *Animal*, is not the sudden product of a Fluid, or *Colliquamentum*, but does much rather proceed from an *Animalcule* of the same Kind, and has all its little Members folded up according to their several *Joints* and *Plicatures*, which are afterwards enlarged and distended, as we see in *Plants*. Now, though this Consideration alone may seem not to bear much Weight, yet being joyned to the two former, they do mutually strengthen each other. And indeed, all the Laws of Motions which are as yet discovered, can give but a very lame Account of the Forming of a *Plant* or *Animal*. We see how wretchedly *Des Cartes* came off, when he began to apply them to this Subject. They are formed by Laws yet unknown to Mankind, and it seems most probable, that the *Stamina* of all the *Plants* and *Animals* that have been, or ever shall be in the World, have been formed *ab Origine Mundi*, by the Almighty Creator, within the first of each respective Kind. And he who considers the Nature of *Vision*, that it does not give us the true Magnitude, but the proportion of Things, and that which seems to our naked Eye but a point, may

may truly be made up of as many parts as seem to us to be in the whole visible World, will not think this an absurd or impossible thing.

But the second Thing, which later Discoveries have made probable, is, that these *Animalcules* are originally in *Semine Marium*, & non in *Fæminis* : And this I collect from these Considerations.

1. That there are innumerable *Animalcula* in *semine Masculo omnium Animalium*. M. *Leewenboeck* has made this so evident by so many Observations, that I do not in the least question the Truth of the Thing.

2. The observing of the *Rudiments* of the *Fætus* in Eggs, which have been *Fæcundated* by the Male, and the seeing no such Thing in those which are not *Fæcundated*, as appears by *Malpighius* his Observations, makes it very probable, that these *Rudiments* proceeded originally from the Male, and not from the Female.

3. The Resemblance between the *Rudiments* of the *Fætus in Ovo*, both before and after *Incubation*, and the *Animalcule*, makes it very probable, that they are one and the same. The same Shape and Figure which M. *Leewenboeck* gives us of the *Animalcule*, *Malpighius* likewise gives us of the *Rudiments* of the *Fætus*, both before and after *Incubation* ; yea, and even the *Fætus's* of Animals, do appear so at first to the naked Eye, so that Dr. *Harvey* does acknowledge that all Animals, even the most perfect, are begotten of a *Worm*. De Gen. Anim. Ex. 18.

4. This gives a rational Account of many *Fætus's* at one Birth, especially that of the Countess of *Holland*, and how at least a whole Cluster of Eggs in a Hen are *fæcundated* by one Coition of the Male.

5. This gives a new Light as it were to the First Prophecy concerning the *Messiah*, that the Seed of the Woman shall bruise the Head of the Serpent : All the rest of Mankind being thus most properly and truly the Seed of the Man.

6. The Analogy I have already mentioned, which we may rationally suppose between the Manner of Propagation of Plants and Animals, does likewise make this probable. Every Herb and Tree bears its Seed after its Kind ; which Seed is nothing else but a little Plant of the same Kind, which being thrown into the Earth, as into its *Uterus*, spreads forth its Roots, and receives its Nourishment, but has its Form within itself ; and we may rationally conjecture some such Analogy in the Propagation of Animals.

The 3d particular which later Discoveries make probable is, That Animals cannot be formed of these *Animalcula* without the *Ova in Fæminis*, which are necessary for supplying of them with proper Nutriment ; and this these Considerations seem to evince. 1. It is probable that an *Animalcule* cannot come forward, if it do not fall into a proper *Nidus*. This we see is the *Cicatricula* in Eggs, and tho' a Million of them should fall into one Egg, none of them would come forward, but what were in the Centre of the *Cicatricula* ; and perhaps the *Nidus*, necessary for their Formation, is so proportioned to their Bulk, that it can hardly contain more than one *Animalcule* ; and this may be the Reason why there are so few Monsters.

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This we see is absolutely necessary in *Oviparis*, and the only Difference, which seems to be between them and the *Vivipara* in this matter, is in this, that in the latter the *Ova* are properly Nothing more but the *Cicatricula*, with its *Colliquamentum*, so that the *Fætus* must spread forth its Roots into the *Uterus* to receive its Nourishment; but the *Eggs* in *Oviparis* may be properly termed an *Uterus* in Relation to the *Fætus*; for they contain, not only the *Cicatricula* with its *Amnion* and the *Colliquamentum*, which is the immediate Nourishment of the *Fætus*, but also the Materials which are to be converted into that *Colliquamentum*, so that the *Fætus* spreads forth its Roots no farther than into the *White* and *Yell* of the *Egg*, from whence it derives all its Nourishment. Now that an *Animalcule* cannot come forward without some such proper *Nidus*, M. *Leewenhoeck* will not readily deny; for if there were nothing needful but their being thrown into the *Uterus*, I do not see why many Hundreds of them should not come forward at once, at least whilst scatter'd in so large a Field.

Vid. Inf. Vol.
III. cap. IV.
§ CXII.
& CIX.

Vid. Inf. Vol.
III. cap. IV.
§ CXVII.

Now, 2. That this *Cicatricula* is not originally in *Utero*, seems evident from the frequent Conceptions which have been found *extra Uterum*; such as the Child which continued 26 Years in the Woman of *Tholouſe's* Belly; and the Little *Fætus* found in the *Abdomen* of *Mad. de S. Mere*, together with the *Testicle* torn and full of clotted Blood; such also seem to be the *Fætus* in the *Abdomen* of the Woman of *Copenhagen*, mentioned in the *Nouvelles des Lettres*, for Sep. 85. all the Members of which were easily to be felt thro' the Skin of the Belly, and which she had carried in her Belly for 4 Years: And the 7 Years Gravitation related by Dr. *Cole*. Now granting once the Necessity of a proper *Nidus*, for the Formation of an *Animalcule* into the *Animal* of its respective Kind, these Observations make it probable, that the *Testes* are the *Ovaria* appropriated for this Use; for though the *Animalcules* coming thither in such Cases, may seem to be extraordinary, and that usually the Impregnation is in *Utero*, yet it may be collected from hence, that the *Cicatricula* or *Ova* to be Impregnated, are in *Testibus Fæmineis*; for if it were not so, the accidental coming of *Animalcules* thither could not make them come forward more than in any other Part of the Body, since they cannot be Formed and Nourished without a proper *Nidus*.

But 3. It is acknowledged by all, that the *Fætus* in *Utero*, for some considerable Time after Conception, has no Connexion with the *Womb*; that it fits wholly loose to it; and is perfectly a little round Egg with the *Fætus* in the midst, which sends forth its *Umbilical Vessels* by Degrees, and at last lays hold on the *Uterus*. Now from hence it seems evident, that the *Cicatricula*, which is the Fountain of the *Animalcule's* Nourishment, does not sprout from the *Uterus*, but it has its Origin elsewhere, and falls in thither as into a fit Soil, from whence it may draw *Nutrimet* for the Growth of the *Fætus*; else it cannot be easily imagined how it should not have an immediate Connexion with the *Uterus* from the Time of Conception.

If you joyn all these three Considerations together, viz. That an *Animalcule* cannot come forward without a proper *Nidus*, or *Cicatricula* ; that there have been frequent *Fœtus's extra Uterum* ; and that they have no *Adhesion* to the *Uterus* for a considerable time after *Conception* ; they seem to make it evident, that *Animals* cannot be formed *ex Animalculis* without the *Ova in Fœminis*. To all these I shall subjoyn the Proposal of an *Experimentum Crucis*, which may seem to determine whether the *Testes Fœminæ* be truly the *Ovaria*, viz. open the *Abdomen* of the Females of some Kinds, and cut out these *Testicles*, and this will determine whether they be absolutely necessary for the *Formation* of *Animals*.

It is indeed difficult to conceive, how these *Eggs* should be *Impregnated per Semen Maris*, both because there is no *Connection* between the *Tube* and the *Ovary* for its *Transmission* ; and for that *Dr. Harvey* could never discover any thing of it *in Utero*. But as to the last, *M. Leewenboeck* has cleared that Difficulty, by the Discovery of innumerable *Animalcula Seminis Maris in Cornubus Uteri*, and those living a considerable Time after *Coition*. And as to the former, we may either suppose that there is such an *Inflation* of the *Tuba*, or *Cornua Uteri Tempore Coitionis*, as makes them embrace the *Ovaria*, and such an *Approach* of the *Uterus* and its *Cornua*, as that it may easily transmit the Seed into the *Ovary* : Or else, that the *Ova* are *Impregnated* by the *Animalcules* after they descend into the *Uterus*, and not in the *Ovary*. The former seems probable, for this Reason, that at least a whole Cluster of *Eggs* in a *Hen* will be *Fecundated* by one *Tread* of the *Cock* ; now this *Fecundation* seems to be in the *Vitellary*, and not in the *Uterus* as the *Eggs* pass along from Day to Day ; for it can hardly be supposed, that the *Animalcules* should subsist so long, being scattered loosely in the *Uterus*, as to wait there for many Days, for the *Fecundation* of the *Eggs* as they pass along. The latter Conjecture has this to strengthen it, that the *Animalcules* are found to live a considerable Time in the *Uterus*, and that if they should *Impregnate* the *Ova* in the *Ovary* itself, the *Fœtus* would encrease so fast, that the *Ova* could not pass through the *Tuba Uteri*, but would either burst the *Ovary*, or fall down into the *Abdomen* from the *Orifices* of the *Tuba* ; and that from thence proceed those extraordinary *Conceptions in Abdomine extra Uterum*.

But *M. Leewenboeck*, to weaken this Consideration, about the *Conception's* being like unto an *Ovum* in the Womb, proposes a Parallel between these *Animalcules* and *Insects*, and insinuates, that as the latter cast their *Skins*, and appear of another Shape, so the other which at first seem like *Tadpoles*, may cast their outward *Skin* and then be round ; and that this may be the *Occasion* of the round Figure of the *Conception* in the Womb. To this it may be replied, That according to *M. Leewenboeck's* own *Sentiment*, the *Animalcules* cannot come forward if they do not find the *Punctum*, or proper Place for their *Nourishment*, to which it seems they must have some *Adhesion*. Now, the *Conception* in *Viviparis* is not fastened unto the Womb for many Days, nor does adhere to any Point of it ; so that it seems this roundish Body is not the *Animalcule* thus changed, after having cast an outer *Skin*, but is rather

rather the *Cicatricula*, or little *Egg*, into which the *Animalcule* has entered, as its *Punctum*, or place of Nourishment ; else I do not see why they should not be *Adhering* to the *Womb* from the *first Conception*, or why, (as I have said) many Hundreds of them are not conceived and formed together.

By Sir J.
Floyer, n.
259. p. 433.

2. I have oft reflected on the Figure of a *Mule*, that being an Animal produced by the Copulation of an *Ass* and a *Mare*, the Extremities of the Body, the Feet, Tail, and Ears, and that black Cross on the Back, resemble that of the *Asses*. By this we may observe, that the Female contains in her Eggs the first Rudiments of the Animal of her own *Species*, and that the *Impregnation* only changes some of the Extremities into a Resemblance of the *Male*. This seems to contradict our new Discoveries ; for, if the Male supplies the *Animalculum*, the *Fœtus* must always be of the same Species as the Male ; if the Female supplie it, of her Kind ; whereas Monsters are observed to be a Mixture of both Species.

CXXVI. Papers of less general Use Omitted.

- n. 77. p. 3004 **Q**uaries concerning *Vegetable Excrescencies*, and the *Insects* bred in them ; by Dr. *Lifter*.
- n. 249. p. 50. 2. Several *Insects* found near *Colchester* ; by Mr. *Dale*.
- n. 8. p. 137. 3. Prodigious Swarms of *Locusts* in *Ukrania* : Extracted from M. *de Beauplan's Description of the Countries of Poland*, and M. *Thevenot's Voyages*. pt. 1.
- n. 72. p. 2171 4. Some general Inquiries concerning *Spiders* ; by Dr. *Mart. Lifter*.
- n. 77. p. 3002 5. *Quaries* concerning *Tarantula's* ; by Dr. *M. Lifter*.
- n. 105. p. 96, 99. 6. Some general *Quaries* concerning Land and Fresh Water Snails ; And part of a *Table* of them, with their Figures ; by Dr. *M. Lifter*.
- n. 222. p. 322 7. An Account of several Rare and Curious Shells, to be met with in *Scotland* ; by Sir. *Rob. Sibbald*.
- n. 100. p. 7002. 8. To prevent the Rot of *Sheep*, by giving them *Spanish Salt* ; Extracted from Mr. *Boyle's Usefulness of Experimental Philosophy*. Tom. 2. p. 15.
- n. 103. p. 50. 9. Inquiries and Directions concerning *Sheep*, and to preserve them, and to improve the Race of *Sheep* for *Hardiness*, and for the finest *Drapery* ; by Dr. *J. Beale*.

CXXVII. Accounts of Books, Omitted.

n. 28. p. 535 **H**istoria Generalis Insectorum, J. Swammerdami. Pars Prima. Ultrajedi,
n. 64. p. 2078 1669. 4to.
n. 76. p. 2281

2. Johannes

A GENERAL INDEX OF ALL

The Matters, contained in all the Five Volumes.

Note, That the Numeral Letters denote the Volume, and the Figures the Page.

N. B. Those Periods which are included in Crotchets thus [] refer to the Continuation: in which the Numeral Letters shew the Part, and the Figures the Page.

A

AN Abscess in the Liver, Vol. III. P. 81.
 Academy of Sciences; the new Regulation of it, II. 1.
Acousticks, I. 457.
 [Acoustick Experiments, I. 374.
Acres, how many in England, IV. 241.]
 An Aged Woman of 60 Years, giving suck to her Grandchild in Germany, III. 80.
 The great Age of *Henry Jenkins*; an account of it, III. 307, 308. The great Age of several Persons in the North of England, and of two Persons in Ireland, III. 308, 309.
 [The great Age of *John Bayles* and others, II. 152.]
Agrick Observations and Improvements, II. 741, to 749.
Agriculture, Improvements of it, II. 748.
 The *Abmella* from Ceylon, II. 648.
Air, The Compression of it under Water, II. 201, 202. The Calculation of it, II. 203. *Air* conceal'd in the Pores of Liquors; Experiments about it in an exhausted Receiver, III.

ceiver, II. 218. *Air* exhausted out of a Receiver; Experiments about wounded Animals in it, II. 222. *Air*; Animals depriv'd of it, and drown'd, how soon they die, II. 223, 224. *Air* rarefied; how soon Animals sicken and die in it, II. 225. *Air* varied as to density; Experiments about Animals in it, II. 227. *Air* rarefied; how long Animals accusom'd to it will live, II. 229, 230. *Air* unfit for Respiration, tho' it retain its density, II. 230, 231. *Air*; the use of it in Respiration, II. 231. Experiments about the weakned Spring, and some unobserved Effects of it, II. 235, to 239. Fresh *Air*; the supply of it necessary to life, III. 66. The *Air*'s resistance to the motion of projected Bodies, I. 484. *Air*; the velocity wherewith it rusheth into an exhausted Receiver, I. 497. The refractive force of the lower *Air*, I. 228.
 [*Air*, Pass through hot Media, III. 166.]
Air-bladders; The use of them in Fishes, II. 846.
Air-Pump; How to take the exhausted Receiver from it, II. 205.

A General INDEX of Matters.

Aix in Provence; the Longitude and Latitude of it, I. 567.

Aleali, mix'd with a clear Sulphureous Spirit, of a red Colour, III. 367.

Aleanna, its nature and effects, II. 645.

Alippo; The Longitude of it, I. 564.

Algebra, I. 1. Defects in it, I. 117.

[Of the Human *Allantois*, II. 87.]

Almon-ao, Our Ancestors us'd to Carve the Courses of the Moon of the whole Year, upon a Carved Stick, which they call'd *Almo-naught*, III. 410.

Aloe Americana describ'd, II. 645.

Allum work describ'd, II. 538, to 541.

An Universal *Alphabet*; an Essay towards it, III. 373, to 378.

Amber, The Production of it, and an Account of it, II. 473, to 490.

[*Amber*, Of its Luminous Quality, III. 158. A Discourse upon it, 260.]

Ambergrease, A Vegetable Production; or an Animal Production, II. 492.

Amomum, III. 646.

[A Course of *Anatomy*, II. 1.]

Andromeda; the *Nebulosa* in the girdle of it, I. 251.

An *Aneurisma* of the Arteria Aorta, III. 257.

Animals Vomited by Children, and a Man at York, III. 135, 136.

[*Animals* in Wales, Scotland and Ireland, IV. 138. & seq.]

Animalcula in Pepper-Water, III. 654, to 656.

Antimony, How to vitrify it with Cawk, II. 555. The Vertue of it, II. 556.

[*Antipathies*, II. 190.]

Antiquities, Several Figures of them, III. 446.

[*Antiquities*, Roman in Wiltshire, IV. 63. in Scotland and Ireland, 145. 64. In Yorkshire, *ibid.* In Lincolnshire, 128. In Wales, 140.]

Annuities, The value of them upon Lives, drawn from the Bills of Mortality at *Breslaw*, III. 669, to 678.

[*Aorta*, Offications in it, II. 34.]

The *Apbelia* of the Planets directly; how to find it, I. 253, 257, 258.

[An *Apopleck* Case, II. 16.]

Apoplexy; the Dissection of a Lady who died of it, III. 29, to 31.

A strange Appearance near *Upsal*, II. 199.

Apertures of Telescopes, I. 191. of Reflecting Telescopes, I. 200.

The Approximation of the Ancients in extracting Roots, I. 98.

[An Improvement of the Method of Approximating in extracting the Roots of Equations in Numbers, I. 81.]

The *Aqueduct* near Versailles, I. 594.

[*Araliastrum*, A Genus of Plants, III. 309.]

Arches; The true Figure of the strongest, I. 41, 50.

Archangel, The Latitude of it, I. 564.

Arch-Work, a peculiar sort of it, I. 595.

Architecture, I. 588.

An *Araometer*, I. 515.

Aries, the first Star of it a double Star, I. 247.

Arithmetick, I. 1.

An Arithmetical Paradox concerning the Chances of Lotteries, III. 679, to 682.

[*Asbestos*, and the incumbustible Cloth made of it, III. 248. Found in Scotland, 250.]

[*Arsenick*, Of the Preparation of it, III. 262.]

Ascites, Observations on a Maid who died of it, III. 140.

Ashes, A shower of them in the *Archipelago*, II. 143.

[*Ascent* of Water between two Glass Planes, III. 181. Of Spirit of Wine, *ibid.* 182. Of Water in Capillary Tubes, *ib.* 184. try'd in *Vacuo*, 190.]

[*Asthmatick* Person dissected II. 37.]

The *Astroites* Describ'd, II. 503, 504, 505.

A New Astronomical Instrument, call'd *Astrodiaticum*, I. 276.

Astronomy, I. 216.

Astronomical Problems; Conick Sections applied to the Solution of them, I. 61.

Arbens, the Latitude of it, I. 564.

Atmosphere, the effects of varying the Weight of it upon Bodies under Water, III. 264.

[*Attraction*, Of the Doctrine, II. 199. Of the Laws of it, I. 57. Of the Attraction of Oyl between two Glass Planes, III. 179.]

Avignon, The Longitude of it, I. 562.

A Bridge at it, I. 593.

[*Aurora Boreales*, III. 116, & seq.]

A General INDEX of Matters.

B.

Ballafore in *India*; the Longitude and Latitude of it, I. 568.

Bark of a Tree separated and reunited to it, II. 706.

Barking of Trees; Observations and Experiments about it, II. 706, to 710.

Barbadoes; Observations made there, III. 560.

The *Barnacle* describ'd, II. 849

The *Scottish Barnacle* and *French Macreufe*, II. 850.

Barometers; Observations made with them, II. 2 to 9. The Agreement of them at *London* and *Townley*, II. 9, 10. A *Barometer* that is portable, II. 10. The Divisions of it, II. 10, 11, 12. Improvements of it, II. 12, 13. The height of *Mercury* in it, at the top of *Snowdon-Hill*, II. 13. At the top of the Monument, II. 14. At any Elevation above the Surface of the Earth, II. 14, 15. The several heights of the *Mercury*, for computing the several Expansions of the Air, and the height and weight of the Atmosphere, II. 16, 17, 18. An account of the ascent of the *Quicksilver*, II. 18, 19, 20. and of the different heights of it, in several Weathers and Climates, II. 20, 21, 22. The Cause of the Suspension of *Mercury* at an unusual height, II. 23, 24, to 28. A Statical *Barometer*, II. 28, 29, 30, 31. The use of *Barometers*, II. 32.

[*Barometer*, One to use on Ship board, I. 368.]

[*Barometrical Experiments* in *Switzerland*, III. 11. Altitudes at *Zurich* and *Upminster*, 13. Cause of the Variation of the *Barometer*, III. 201.]

[*Baroscope*, A new one, I. 370.]

Baths, In *Somersetshire*, II. 336, to 339. In *Austria* and *Hungary*, II. 339, to 344. At *Apomum* near *Padua*, II. 344.

Bermudas; Observations made there, and at *New-Province* and *Virginia*, III. 561.

Bees; Observations about them, II. 772. The Generation of a sort of them in old *Willows*, II. 773, 774. A strange sort of them in the *West-Indies*, and an early Swarm of them, II. 775.

A *Bee-houfe* us'd in *Scotland*, II. 776.

Beetles; Swarms of them in *Ireland*, II. 778, to 782.

[*Bellows*. The *Hessian* improv'd, I. 373.]

Birdlime from *Elder* and *Holly*, II. 701, 702.

[*Birds* in *Yorkshire*, III. 376.]

[*Births*, The Regularity of them in both Sexes, IV. 231.]

A *Bird* living without a Head, II. 23. and one without a Brain, II. 23, to 27.

Black lead; An account of it, II. 462.

A *Schirrous Bladder* containing in it Bags of serous matter, III. 147, 148.

[A *Triple Bladder*, II. 74.]

Bleeding; A strange kind of it in a Child, III. 251.

Blister; The Operation of it when it cureth a Fever, II. 266, to 271.

Blood; The visible Circulation of it, III. 225. The quantity of *Blood* in Men, and the Celerity of its Circulation, III. 225, 226. A Method of Transfusing it, with Considerations and Experiments of Transfusion, III. 226, to 228. The Transfusion of the *Blood* of a Calf into a Sheep, by the Veins only; of the *Blood* of a Mangy into a Sound Dog; of the *Blood* of a Young into an Old Dog; and of Calves into Dogs, III. 228, 229. A plentiful Transfusion of *Blood* try'd upon a Bitch, of the *Blood* of Weathers into an Horse, of the *Blood* of one Lamb into another; of the *Blood* of a Lamb into a Spaniel, III. 230. Transfusion of *Blood*, practis'd upon a Man in *London*, III. 231. The Effects of several Liquors mix'd with the *Blood* warm from the Veins, III. 232. An Observation on *Blood* grown cold, III. 235. Effects of the Air upon *Blood*, explain'd by the change of Colour in a clear Liquor upon admission of Air, III. 235, to 239. White *Blood* found in the Veins, III. 239, 240. The constituent parts of human *Blood*, III. 240, to 247. The Opinion of the College of Physicians at *Rome* concerning the Analysis of Human *Blood*, III. 247, to 251. A periodical evacuation of *Blood*, at the end of the Forefinger, and an eruption of it at the *Glandula Lacrymalis*, III. 252. An admirable essence for stanching *Blood*, and experiments made with it, III. 252, to 255. *Blood* passeth where the Air will not, III. 258.

T t t t 2

[*Blood*

A General INDEX of Matters.

[*Blood*, its Specifick Gravity, II. 137. Observations on it, 144. Of its motion in the veins, I. 418.]

Blossoms do not presently discover a blast, II. 656.

A *Bodkin*, cut out of the Bladder of a Woman, III. 162, 163.

A *Body* long buried, almost wholly converted into Hair, III. 13, 14.

Bogs and Loughs improv'd and drain'd in Ireland, II. 732, 733. The inconveniences and advantages of them, II. 733, 734. The inconveniences remedied by draining, II. 735, 736. The motion of a *Bog* in Ireland, II. 737, 738.

The *Bones* of a Sceleton, united without joynting or cartilage, with figures, III. 293, to 295.

[*Bones*, strange ones dug up near Canterbury, IV. 27. near Colchester, 112. near St. Albans *ibid.*]

Bony Excrescences on a human Skull, with Remarks on them, III. 295, to 297.

The *Bononian* stone; Statues made of it, III. 246.

Bowels; The order of them inverted, III. 111.

The *Brain* depress'd into the hollow of the *Vertebrae* of the neck, III. 26. One Hemisphere of it sphacelated with a stone in it, III. 27, 28.

[*Bramines* in the East Indies, their Opinions and way of Worship, IV. 172.]

Brasil and Congo; Observations in them, III. 623.

Brass; how to make it, II. 565.

Bread made of Turnips and Potatoes, II. 630.

Breasts of a Woman suddenly excessively swell'd, III. 78, 79.

[*Breast*, Tumors there, II. 24.]

Bridges at St. Esprit, in France, at Avignon and at Rome, I. 593.

A *Bridge* 70 Foot long, without any Pillar under it, I. 594.

Bridge-Town in Barbadoes, I. 570.

[*Britain*, whether once a Peninsula, IV. 33. & seqq.]

Building, Stones fit for it, I. 588.

A *Bullet* voided by Urine, III. 160, 161.

Bulimia; an Account of it, III. 111.

Burning-Coal and shining Wood; Observations about the Resemblances and Differences between them, III. 646, to 649.

Burning Mountains in the Molucca-Islands; an Account of them, II. 391, to 395.

Burning Concaves, I. 211.

C

The *Cacao Tree* describ'd, II. 662, 663.

Calash; a new sort of it, I. 504.

Calendar; A Report upon the Consultation of Mr. Des's Proposal for reforming it, in 1582. III. 404. Another Proposal for reforming it, III. 405, 406. The Conclusion of the Protestant States in Germany in 1699, for reforming the *Calendar*, III. 408.

[*Calenture*, an Account of one, II. 187.]

[*California*; an Account of it, IV. 211.]

[*Callus* supplying the loss of Bones, II. 149.]

A monstrous *Calf*, II. 899. A *Calf* with two Heads, II. 899, 900.

[*Calves*, monstrous ones, III. 330.]

Camelion; Observations on it, II. 816.

[*Canary Seed*, how to cultivate it, III. 296.]

Cancelli, or Soldiers, II. 832.

[*Cancer*; an unusual one, II. 16.]

[*Cantharides*, of their internal use, II. 216.]

Canton, Longitude of it, I. 569.

Cape-Corse; Observations made there, III. 658.

[*Cape of Good-Hope*, some Account of it, IV. 185.]

Carriages; Advantages of high Wheels to them, I. 503.

Carps; a new way of catching them, II. 837.

[*Carteia*, where situated, IV. 50.]

[*Cassini* (Monk) of his Orbit, I. 237.]

Castorium, the Russian way of curing it, II. 872.

The *Catacombs* at Rome, III. 448, to 451.

A *Cataract* in Gottenburg, II. 325.

The *Catena*, I. 39.

Caterpillars; the true Origine of them, H. 759.

[*Cattle*; Distempers among them, III. 340.]

The *Cecum* of a Bitch cut out, and extended with almost liquid matter, III. 112. extended with Cherry-stones, III. 113. The use of it, III. 114.

[*Center* of Oscillation, I. 48.]

[*Centripetal Force*, of its Laws, I. 63.]

Ceruse; the way of making it, II. 576, 577.

Cesar's Descent upon Britain, the time and

Calculus;

A General INDEX of Matters.

- Calcis*; Latitude of it, I. 564.
 place of it, III. 412, to 415.
Chalk and other bodies not properly stones, II. 462.
 [Chance. Of the Laws of Chance I. 190.]
 Ancient Characters with remarks on them, III. 530. 531.
 The Charges of Reflecting Telescopes, I. 200.
Cherries recover'd, tho' almost wither'd, II. 652.
Chickens; the manner of hatching them at Cairo, III. 851.
 A Child 26 Years in the Mother's Belly, taken out of the Uterus; III. 217.
 [Child, one crying in the Womb. II. 121.
 One deliver'd full of the Small Pox, 175.
 An emaciated one dissected, II. 190.]
 [Childbirth; A Hydrops Ovarii in a Puerpera, II. 113. Dissection of a Woman dying in Childbirth, 112. One suppos'd to have continued many years with Child. 123.]
Chile; the passage of it to the Breasts, III. 78. the Colour of it, III. 101, 102. Distribution of it, III. 106.
Chilification, how made, III. 106, to 110.
 A Stone-Chimney, with a peculiar sort of Arch-work, I. 595.
Chymical Observations and Experiments, III. 351, to 359.
 [China, some Account of it, IV. 177.]
China-Dishes; an Imitation of them, III. 658.
China-Varnishes; how to make them, I 602.
 The Chinese way of making Gold-Thread, III. 658.
Chronological Problems solv'd, viz. To find the Prime, Solar Cycle and Indiction; what Day of the Week any Day of the Month happens; the Sun's Entrance into any Sign, III. 401, 402.
Crystals; the formation of them, II. 465.
 Rock Crystal, Optic Lens's of it, I. 193.
Cider; a new way of improving it by the Cask, II. 656.
Cinnamon and Milium describ'd, II. 664.
 The Circle squar'd, I. 15. A Quadratrix to it, describ'd by its Equable Evolution, I. 36.
Clays, a Table of them, II. 451, 455.
 Pendulum-Clocks, I. 465. A Clock Ascendent on an Inclined Plain, I. 467. A Clock Descendent on an Inclined Plain, I. 468.
Clash incombustible describ'd, II. 549, to 554.
Clash; an Engine to weave it, I. 501.
 A Coalescence of the Vagina Uteri; and notwithstanding that, a Woman with Child, III. 216.
Coal-Mines in Somersetshire, II. 458.
 [Coal-Pits, the Strata of one at Dudley, III. 236. at Mendip, Somersetshire, III. 237.]
Cochineal-Fly, with figures of it, II. 784-785.
Cockles in East-India, II. 831.
Coffee; an Account of it, and the Coffee-Shrub, II. 659, to 662.
 [Coins ancient, IV. 130.]
Cold; the Effects of it in the Northern Countries, II. 152. Cold produc'd with Sal Armoniac, II. 161, to 164.
 [Cold Dissolutions, and Fermentations, III. 4.]
 [Colick. Two cases of it, II. 80.]
 [A Colliery blown up, III. 240.]
 The new Star in Collo Ceti, I. 251.
Colours and Light; a new Theory of them, I. 128.
Colours and Dyes; Observations about them, III. 655, to 661.
 A Description of some simple Colours, I. 601.
 To Colour Stone. I. 603.
 A monstrous Col, II. 899.
 [Combinations and Alternations, an improvement of the Doctrine, I. 184.]
Comets; An. 1664. I. 436. An. 1665. I. 438. An. 1668. I. 438. An. 1672. I. 439. An. 1677. I. 443. An. 1680. I. 446. An. 1682. I. 446.
Comets; an Hypothesis of their Motion. I. 437.
Comets; An. 1683. I. 448. An. 1684. I. 451. An. 1686. I. 452. An. 1699. I. 452.
 [Comets. A History of them, I. 325. Observations on that in 1664, 338. in 1680, 339. A Telescopic one, 340. One in 1717. 342.]
 A Compass invariable, and the Account of it examin'd, II. 620, to 625.
Compound-Interest and Annuities; Problems concerning them, III. 678, 679.
Burning Concaves, I. 211.
Concaves nearly Parabolical, I. 214.
 A false and preternatural Conception, III. 220, to 222.
 [Conick Sections; Some Properties of them, I. 1]

A General INDEX of Matters.

A Coniferous Tree from the Cape of Good-Hope, II. 673.

Spherical Conick Sections applied to Trigonometry, I. 62.

The *Connaught Worm*, II. 758.

The trembling of *Consonant* strings, I. 606.

An Engine Consuming Smoke, III. 638.

Constantinople; Historical Observations relating to it, III. 465, to 475. Latitude of it, I. 564.

An odd *Convulsion* in the Cheek, III. 34.

A periodical *Convulsion*, III. 35. A periodical Disease of the Convulsive kind, III. 36.

Copenhagen; the Longitude of it, I. 563

[*Copenhagen*; the King's Chambers of Rarities there, IV. 166.]

Copper-Mines in Hungary, in Lancashire and Cumberland, II. 562, to 565.

Corinth; the Latitude of it, I. 564

Coron; the Latitude of it, I. 564.

Cortex Winiéranus describ'd, II. 666, 667.

[*Cosivensis*; An extraordinary Case of it, II. 82.]

A Cow with 4 Calves, II. 904.

Crawfish; Stones in the Head of them, II. 831.

Cube; the doubling of it, I. 9.

The *Cuntur* of Peru, II. 860.

A Problematical *Curve*, I. 33.

Tangents to *Curves*, I. 18, 116. The Rectification of several *Curves*, I. 116.

The Transformation of *Curves*, I. 116.

The Quadrature of Irrational *Curves*, I. 52. Of the Logarithmick *Curves*, I. 56.

[*Curves*; Of squaring them, I. 5. Of the length of *Curve Lines*, I. 28. A *Curve* of the third order, I. 29. Construction of *Curves*, 30. Description of them, 35. *Curve* of quickest Descent, 37.]

Cycloidal Spaces perfectly quadrable, I. 116.

The *Cycloide* consider'd by Cardinal Cusanus, before 1451; I. 116. A general Proposition for measuring all *Cycloids* and *Epicycloids*, I. 32.

The new Star in *Pectore Cygni*, I. 241.

The new Star sub *Capite Cygni*, I. 248.

The Proportion of Spheres to their containing *Cylinders*, I. 58.

D

The Equality of Natural *Days*, refuted, I. 270.

Dantzick; the Longitude and Latitude of it, I. 559, 563.

Deafness; an Experiment concerning it, III. 32.

Persons *Deaf* and Dumb, taught to speak and understand a Language, III. 389, to 393. A Method of instructing Persons *Deaf* and Dumb, to speak and understand a Language, III. 393, to 397.

[*Deaf* and Dumb Person who recover'd his Speech and Hearing after a Fever, II. 166. *Deaf* Persons who could speak and know what was said by the motion of the Lip. IV. 216.]

The *Death-watch* describ'd, II. 785.

[A further Account of the *Death Watch*, III. 391.]

Delphos; the Latitude of it, I. 564.

Deluge; an Account of it, and the Antediluvian World, II. 430.

Derby; the Longitude and Latitude of it, I. 560.

Descent, the line of quickest *Descent*, I. 463.

How much the *Descent* is quicker in a Cycloide, than in a streight Line, I. 465.

Effects of Gravity in the *Descent* of heavy Bodies, I. 472.

Devils-bis; its Vertues, II. 45.

Dew like Butter in Ireland, II. 643.

Diamonds; an account of them, II. 467, to 473.

[*Diamonds*; of their luminous quality, III. 158.]

[*Differential Method* illustrated, I. 123.]

Digestion; experiments about it, III. 94, 95. An ill *Digestion* by too much study, III. 110.

Diseases; the Motions of them, and the Birth and Deaths of Animals in different times of the Natural Day, III. 311. *Diseases* change with the Tides, but Deaths are at no certain hour of the Tides, III. 311, 312.

The *Dissention* of Malpighi, III. 31. of a Boy who died suddenly, II. 32.

The *Distances* of two unknown places, from 3 known Objects, where one of them is not Visible at one station, and another of them at the other, I. 122.

The *Distance* of 2 unknown places, from 4 known Objects, where only 2 of them are Visible at one Station, and the other two at the other Station, I. 123.

The

A General INDEX of Matters.

- The Distance of an unknown place from 3 known Objects at 1 Station, I. 120.
- The Distances of 2 unknown places, from 2 known Objects at 2 Stations, I. 122.
- To measure Distances at one Station, I. 192. with a Telescope, *ibid.*
- To measure small Distances, I. 216, to 220.
- Cold Distillations, an account of them, III. 315.
- [Diving, How to live under Water, I. 419.]
- [Divisibility, Infinite of Matter, I. 45.]
- A Dog dying on firing Volleys of small Shot, III. 650.
- Dogs; The Diseases of them, II. 870.
- [Donington, Some account of it, IV. 136.]
- A Monstrous Double-Cat, II. 901, 902
- A Double-Pear, II. 653.
- A Monstrous Double-Turkey, II. 898.
- An excellent Drink from Apples and Mulberries, II. 656.
- [Drink and Urine, a new Passage for them, II. 77.]
- Dropsy; Observations on a Man who died of it, III. 139 Dropsy mistaken for Gravitation, III. 139. Observations on a Woman who died of a Dropsy after the Puerperalis, III. 141. The true Cause of the Dropsy, III. 142. The Cure of it, III. 143. A Dropsy in one of the Ovaries of a Woman, III. 207.
- [Dura Mater, an Experiment of its Motion, II. 15.]
- Dysenteries; an infallible Cure for them, III. 114, to 118.
- E.
- [Eagles Roman, A Discourse of them, IV. 27.]
- [Ear, Observations upon it, II. 20.]
- [Earth, An uncommon sinking of it, IV. 243.]
- An Earthquake near Oxford, in 1665, describ'd, II. 396. An Earthquake at Oxford in 1683, II. 396, to 400. in the Midland Counties, in 1683, II. 400. An Earthquake in Sicily in 1693, II. 400, to 406. In January 1693. with the number of the Inhabitants that perish'd by it, II. 406, to 410. An Earthquake at Lima in 1687, and in Jamaica in 1687, and 1688, II. 410. A Dreadful Earthquake in Jamaica, in 1692, II. 411, 412. A more particular account of it, II. 413, to 419. An Earthquake in Batavia, in 1699, II. 419, 420. The Cause of Earthquakes and Vulcano's, II. 420, to 423.
- [Earthquakes, III. 109.]
- [Easter, The Rule to find it in the Common Prayer-Book explain'd, IV. 11.]
- [East-Indians, Their Mechanick Arts and Physick, IV. 197.]
- East-Indies; Observations in two Voyages to them, III. 614, to 617. Observations in them, III. 607, to 629.
- Echoes, The Reflections of Sounds, I. 506.
- Eclipses of the Sun, how to observe them, I. 280. Lunar Eclipses; Directions how to observe them, I. 300. Satellite Eclipses, I. 407.
- [Eclipses of the Sun, I. 264. Of the Moon, 283, 365.]
- The Obliquity of the Ecliptic, according to the Ancients, I. 206. The Obliquity of the Ecliptic, and Elevation of the Pole remain unchang'd, I. 263.
- Eton in Northamptonshire, the Latitude of it, I. 360.
- Eels; Discover'd plentifully in Frosts, in Somersetshire, II. 837. Two very large, *ibid.* The Generation of them, II. 837, 838.
- An Egg found within an another Egg, II. 904. An Egg found in the *Tuba Fallopiana* of a Woman, III. 208, 209.
- Eden-hole in Derbyshire, describ'd, II. 370.
- An Elephant found under ground near Erfurt in Germany, II. 438, to 450.
- [Elephants, How they are caught and tam'd in Ceylon, III. 315. Of the Structure of its Ear, 317.]
- The Electrical Power of Stones in relation to Vegetable Resin, II. 491. Electrical Bodies; a Catalogue of them, *ibid.*
- Elms-feed; an account of the Propagation of it, II. 667.
- An Embryo of 4 Weeks, with Figures, III. 208, 209.
- The Emmer, or Ant describ'd, II. 789, to 791.
- English Chandel; A Caution to Seamen bound up it, I. 583.

A General INDEX of Matters.

Epidemical Distempers; Observations on them, III. 271, to 274.

Epicycloide, The Quadrature of a Portion of it, I. 31.

Epicycloides, And *Cycloides*; a general Proposition for measuring of them, I. 32.

[*Epileptick Fits*, II. 188.]

The *Equality* of Natural Days refuted, I. 270.

Affected *Equations* in Numbers; Improvements in England in the Resolution of them, I. 60.

Cubic and Biquadratic *Equations*; the Construction of them, by a Parabola and a Circle, I. 63. The number of Roots in such *Equations* with their Limits and Signs, I. 68.

Equations, Infinitesimal solv'd analytically, I. 79. An Improvement of the Method of approximating in extracting their Roots in Numbers, I. 81. Solution of Cubick and Biquadrattick *Equations*, 137.]

An *Equation-Table*, Calculated for the Sun's place, I. 272. An *Equation-Table*, calculated for the Days of the Months, I. 348.

The *Equinoxes* observ'd, An. 1699. I. 180.

Eridanus; A new Star in it, I. 252.

An *Essay*-Instrument, I. 316.

The Bridge at St. *Esprit* in France, compared with some other famous Bridges, I. 393.

Some of *Euclid's* Propositions demonstrated independently from the rest, I. 7.

Ever greens, Remedies for them when decay'd, II. 751. Cautions about exposing of them, *ibid.* Fiery *Exhalations* or Damps, II. 181, 182.

[*Excrescences* on the Fingers, II. 192.]

[*Exhalations* nocturnal in the Indies, III. 148.]

The Doctrine of *Exhaustions*, I. 98.

Exotic Diseases propagated by Trade and Infection, III. 274.

The Different *Expansion* of several Fluids in Winter and Summer, I. 326.

[*Experiments* of the Descent of Bodies of different Weights, &c. III. 161.]

To raise an infinite Multinomial, I. 90.

The *Extraction* of the Roots of an infinite Equation, I. 95.

The Approximation of the Ancients in *Extracting* Roots, I. 98.

The *Extraction* of Roots, without any previous Reduction, I. 81.

Eyes; Several remarkable Cases relating to them, III. 40, 41.

[*Eye*, A distemper'd Optrick Nerve, II. 113. Observations on Incisions of the Cornea, 18.]

Eyes of Horses; a Blemish peculiar to them, II. 864.

F.

The *Face* of a Man differently affected by various Objects, III. 8, 9.

The *Face* of a Child 6 Years old as large as that of a full grown Woman, III. 20, 21.

[An unusual Blackness in the *Face*, II. 16.]

Fairy Circles; An account of them, II. 182.

Falling-Sickness; The cure of it, III. 33.

Facitious Substances; 4 sorts of them, III. 345, 346.

Faces discharg'd at an Ulcer in the Groyn, III. 119.

Fetus; The Respiration and Nourishment of it, in *Utero Materno*, III. 209, 210.

A *Fetus* form'd in the Ovarium, III. 212,

213. A *Fetus* lying without the *Uterus* in

the Belly, III. 214. to 216. A *Fetus* in

the right Horn of the *Uterus*, III. 216. A

Fetus, whose Bones were voided *per anum*,

some Years after Conception, III. 218. A

Fetus voided at an ulcerated Navel, III. 219.

The Bones of a *Fetus* voided above the *Os*

Pubis, *ibid.*

Small *Fetus's*; How to preserve them, III. 650.

[*Fetus's* voided an unusual way, II. 119.]

Figures of several parts of the Body designed and explain'd, II. 809.

Fire; An Eruption of it, II. 385. An Engine for quenching *Fire*, I. 544.

A *Fiery Mixture*, the Accension and Explosion of it in *Vacuo*, III. 364. A Comparison between this *Fiery Mixture* and

Gunpowder, III. 365, 366.

Fish; the Eyes of them, and the Structure of the Internal parts of them, II. 847,

848.

Fishes; a Shower of them in Kent, II. 441.

A General INDEX of Matters.

[*Fishes* put into Water, the Air exhausted, and other Circumstances, III. 177.]

[*Fishes* in Yorkshire, III. 376.]

An actual *Flame* produc'd by two cold Liquors mix'd together, III. 359.

[*Flanders*, Curiosities there, IV. 152.]

Fleas; The Generation of them, II. 789.

Fluids; How to weigh them, I. 515. The superficial Figure of *Fluids* contiguous to other *Fluids*; their Reflective power, I. 526.

The *Flux* and *Reflux* of Euripus, II. 289, 290.

[*Fluxes*, a Cure for them, II. 167.]

Fluxions, Several Instances of the use of them, in the Solution of Geometrical Problems, I. 34.

Several Attempts to *Fly*, I. 499.

An Engine for *Flying*, I. 500.

A *Flying* Hart, II. 782, 783.

Eyes; How to generate them for giving a Tincture, II. 784, 785.

Flying Grasshoppers in Languedoc, II. 788.

The principal *Foci* of Optick Glasses, I. 183. Convex glasses of a small Sphere with their *Foci* at a great distance, I. 193.

Fountains and *Rivers*; the Original of them, II. 329, 330. *Fountains* boyling and subterraneous Steams, II. 349, 350.

Fossile-Shells, in Italy, France, and in several places of England, as Kent and Berkshire, II. 425, to 428.

Fossile shells, and *Fishes* in Lincolnshire, II. 428, 429.

[*Fossils* of *Reculver Cliff*, III. 252. at *Harwich Cliff*, 253. in *Wales*, *Scotland* and *Ireland*, III. 253. IV. 139. & *Seqq.*]

The *Fossile tongue* of a *Pastinaca Marina*, II. 431, 432.

Fowl; Observations on the heads of them II. 860, to 862. The *Anus* of them applied in Malignant Distempers, II. 863.

[A Pin in a *Fowl's* Gizzard, III. 357]

The Sum of Infinitely infinite *Fractions*, I. 104.

A Map of *France*, I. 571.

[Of drawing a Meridian Line through *France*, I. 424.]

Observables near *Frankfort* on the Oder, III. 603.

Frankfort on the Maine; Bills of *Marriages*, *Births* and *Burials* in it, III. 667.

Vol. III.

Freezing; Experiments about it, II. 164, 165.

Friction; The great effects of it, III. 10, 11.

Frogs; Observations on their Lungs, II. 817.

Frost; The effects of it in 168 $\frac{1}{2}$ II. 153, to 161.

[*Frost* in 1708. III. 98.]

Fruit-Trees; Choice of them for speedy Propagation and pleasant Liquor, II. 653, 654. An easy way of raising and Transplanting them, II. 655, 656.

Fruit and *Flowers*; how to make them grow in Winter, and how to keep them a whole Year, III. 759.

A Subterraneous *Fungus*, II. 458, 459.

G

Terra del Gada in *Madagascar*; the Longitude of it, I. 568.

The *Gall-Flee*, II. 769.

[*Gangrene*, Causing the Loos of the Leg, and part of the Thigh, II. 149.]

Garden, II. 907, to 912.

Gardening improv'd, II. 749.

Generation spontaneous, II. 765:

Geography, I. 546.

Geometry, I. 1.

Giants-Causeway in *Ireland*, II. 511. to 519.

[*Gibraltar*, Some account of it, and the adjacent Country, IV. 50.]

[*Ginzeng*, a *Tartarian* Plant, III. 305.]

Glands; The Structure and use of them, III. 86, to 88.

Two new *Glands* near the *Prostatae*, with their Excretory Ducts, lately discover'd, III. 194.

*Glandule Miliare*s describ'd, III. 93. A Bed of *Glands* found in the Stomach of a Jack, III. 93, 94.

A *Glandulous* Substance found between the Heart and *Pericardium* of an Ox, III. 69.

Glass; How to paint it in Marble Colours III. 658.

[*Glass-Tubes*, Of their action upon Water, and Quick silver, III. 192.]

An exceeding large *Globe*, I. 216.

A small *Coelestial Globe* of Steel, which keeps equal pace with the Heavens, I. 216.

U u u

Glossopetra

A General INDEX of Matters.

Glossopetra Describ'd, II. 431.
Gloworm; Observations on it, II. 760.
 The flying *Gloworm* Describ'd, II. 761.
Gold, How to gild it upon Silver, III. 657.
Gold-Mines in Hungary, II. 585, to 587.
Cape of Good-Hope, the Longitude of it, I. 567.
Granaries in London, at Zurich, and in Dantzick, and Muscovy, II. 628, to 630.
Gravity, The effects of it in the Descent of Heavy Bodies, and the Motion of Projects, I. 473. The Properties of it, I. 472.
Greatrix the Stroker; Cures done by him, III. 11, 12.
Green-Copperas Works, II. 531, to 534.
Green Worms in Wales, II. 758.
Grindlewald, An Icy Mountain in Switzerland, III. 252.]
Ground, fertiliz'd by Frost, II. 728. by Brine, *Ibid.* Improv'd by Salt, and by Sea-Sand in Cornwall, II. 728, to 730.
 [Ground, of manuring it by Sea Shells, III. 286. by Sea Sand, III. 289.]
Gum Lac, Of its Luminous quality, III. 158.]
Hard Gums from Plants, II. 700.
Guns, Experiments determining the Point-blank distance, the just Charge of Powder, and the best size of Great Guns, I. 492.
Wind-Guns, I. 496.
Great Guns; the force of several sorts of them, I. 495.
 [Gurnard Yellow describ'd, III. 378]
 [Gut of a Dog cut and cur'd, II. 79.]

H

[*Hæmorrhages*, unusual and periodical, II. 145. & seqq.]
Hail-Stones of extraordinary bigness, II. 441. Very large in Flanders; extraordinary in Wales and Cheshire, II. 145, 146. A Storm of them in Hertfordshire, in May 1697, II. 147. In Herefordshire, and in Monmouthshire, June 1697, II. 148.
Hair found in several parts of the Body; Observations upon it, III. 14, to 16. And upon the *Hair* found in the Body of a Woman that died in Child-bed, III. 16, 17.
Hair-Worms describ'd, II. 771.
Halo's, at Madrid, Paris, Dantzick, and Oxford, II. 185. *Halo's* and *Parhelia's*, the Causes of them, II. 189, to 194.

[*Hare* dissected, III. 337]
 [Harwich Cliff, an account of it, III. 253.]
 [Head, an unusual Bone taken out of it, II. 13. a Bullet taken out that had lain there 30 Years, 14.]
Healing-Springs; Observations upon them, II. 345, to 349.
Hearing, the Organ of it describ'd, II. 43, to 56.
Heart, the Motion of it describ'd, III. 69.
 [Of the Motion of the *Heart*, II. 41.]
 [A left Ventricle of the *Heart*, of a prodigious size, II. 40.]
 The *Hearts* of cold Animals taken out of their Bodies continue to beat in an Exhausted Receiver for an hour or two, II. 222.
 [Heat, a Scale of the degrees of it, III. 1.]
Heats excessive in Poland, II. 165. The proportional *Heat* of the Sun in all Latitudes, II. 165, to 169.
St. Helena, The Longitude of it, I. 568.
Hemlock, The effects of it describ'd, II. 640. A root like it, that caus'd Madness, II. 641.
Hemlock-Water Drop-wort, the fatal effects of it, II. 641, 642.
 A *Hen* with a perfect Chick in the Ovary, II. 904.
Herbs of the same make and Class have generally the like Vertue, II. 704, to 706.
 A *Hermaphrodite* at London and at Thoulouse, III. 306.
 [Hessian Bellows improv'd, I. 373.]
 The Island *Hirta*; a Description of it, III. 541, to 543.
 [Holland, Remarkables there, IV. 171.]
Hollandia Nova, Observations in it, II. 622.
Honfleur, the Longitude of it, I. 650.
 [Horace, A Passage of that Poet explain'd, IV. 13.]
Horizon, Celestial Objects appear greater near it, than when higher elevated, I. 221.
 A *Horn* hanging at the Neck of an Ox, II. 865, to 869.
Horny Excrescencies in an Irish Girl, and a Boy at France, III. 12, 13.
 [Hottentots, Of their Country and Customs, IV. 186.]
Houses and *Hearths*; the number of them in Dublin, III. 665.
Human Testimony; the credibility of it, III. 662, to 665.

The

A General INDEX of Matters.

The *Humming-Bird* describ'd, II. 854.
 855
Hungarian Bolus, III. 457.
Hurricanes and Storms, II. 102, to 104.
 Prognosticks of them, II. 105, to 109.
 [*Hydatides* evacuated, II. 97.]
Hydraulick, I. 515.
 An *Hydrocephalus* describ'd, III. 28, 29.
Hydrophoby, its Symptoms and Cure, III. 211, to 281.
 [Cases of the *Hydrophoby*, II. 160.]
 A Woman *Hydropical* in the external Tunic of the *Uterus*, and in the left Testicle, III. 205, to 207.
 [*Hydropical Cases*, II. 84. & seqq.]
Hygrosopes describ'd, II. 36, to 42.
Hydrostaticks, I. 515.
 The *Hyperbola* squar'd, I. 10.
 The Generation of an *Hyperbolical Cylinder*, I. 188. Applied to the finding of *Hyperbolical Optick Glasses*, I. 189.
 [*Hypocausta*, Of the Ancients, IV. 69.]

I

Jamaica Pepper-tree, II. 663. 664.
 A Contumacious *Faundice* attended with an odd Case in Vision, III. 286.
Japan, Observations in it, III. 610.
Ice and Snow how to preserve it, II. 161.
Iceland, an account of it, III. 609.
Ichneumon-wasps, and the manner of laying their Eggs in the bodies of Caterpillars, II. 769, 770.
Icy-Mountain Gletcher, II. 465.
 [*Icy-Mountain Grindewald*, III. 252.]
 [An *Idiot* swallowing Brass, Iron, Lead, &c. II. 96.]
 [*Jesuits Bark*, an account of it, III. 303.]
 [*Iliaca Passio*, an unusual Case, III. 86.]
 To make the *Image* of any thing appear in a light room, I. 206.
Imagination, extraordinary effects of the Strength of it, III. 222.
 [Other instances of the force of *Imagination*, II. 191.]
 A Man of a strange *Imitating Nature*, III. 8.
 [The strange effects of *Indian Varnish*, II. 226.]
Infection, an Universal preservative against it, III. 376.
 The Doctrine of *Infinities*, I. 98.

The Proportion of *Infinite Quantities*, I. 102. *Ininitely Infinite Fractions*, I. 104.
 Two clear *Inflammable Liquors*, being mix'd, give a *Carnation Colour*, III. 367.
Inscription; An uncommon *Inscription* on a very great basis of a pillar, lately dug up at Rome, explain'd by Vossius, III. 446, 447. An *Etruscan Inscription* III. 448. An *Inscription* in the Language of the *Palmyreni*, with Draughts of several *Inscriptions* and Characters, at *Persepolis*, III. 126.
 [*Inscriptions*, a *Tuscan* one, IV. 112. one from *Arragon*, 116. in the North of England, 118, 127.]
Insects, the generation of them, II. 759.
 Swarms of them strange and mischievous in *New-England*, II. 763.
Insect-Husks of the *Kermes-kind*, II. 766.
 An *Insect* Musk-scented feeding on *Herbane*, and others Musk-scented, II. 783, 784. One yielding an *Acid Juice*, II. 792.
 [*Insects* in the Barks of Trees, III. 388. remarkable ones in *Spain*, III. 396.]
 [*Instruments* of Brass found under ground in *Yorkshire*; with Remarks, IV. 70.]
 [*Interest Money*, A Correction of the common way of computing it, I. 145.]
 [*Intestines* of a Child found in the Cavity of its *Thorax*, II. 38. a strange Concretion of them, 81.]
Intestines, the Spiral Structure of the Fibres of them, III. 88, to 91.
Inundations in *Galcoyne*, in *Ireland*, in *Yorkshire*, and in *Mauritius Island*, II. 326, 327, to 330.
 [*Inundations* in *Ireland*, III. 216. in *Craven*, *ibid.*]
 [*Iquetiaia*, a Plant from *Brasil*, III. 301.]
Ireland, several things in it in common with the *West Indies*, III. 544.
 [Some Remarkables in *Ireland*, IV. 145.]
Iris, one odd-figur'd, II. 466.
 An *Irish man* of an extraordinary Size, III. 1.
Irish-Slate, an account of it, II. 462.
Iron, how to give it a Copper-colour, III. 657.
Iron-works, in *Glocestershire*, and in *Lancashire*, II. 458, to 560.
 [*Island*, a new one rais'd in the Archipelago, IV. 199.]
 [*Italy*, Plants and Curiosities there, IV. 155. & seqq.]
 [*Itch*, Of the Worms in it, II. 156.]

U u u u a

Juices

A General INDEX of Matters.

Juices of Plants; their nature and differences, Juices caking and not letting go the whey; Saffron colour'd *Juice*, II. 698. 699. *Juices* Stringy, Oily, and Clammy. II. 701, to 793.

The *Julian* Account not to be chang'd for the Gregorian. II. 406, to 408.

Julian period; how to find the Year of it demonstrated, II. 399, 400.

Jupiter, a Transit of the Moon above it, An. 1671. I. 347. An occultation of *Jupiter*, An. 1679. I. 353. An. 1686, I. 359. to 364. A Transit of the Moon below *Jupiter*, An. 1682. I. 357. The Phasis of *Jupiter*, I. 382. The Rotation of *Jupiter* upon his Axis, I. 382. Places of *Jupiter* observ'd, I. 384. The Conjunctions of Saturn and *Jupiter*, An. 1682. and 1688. I. 389. A Table of the mean Conjunctions of Saturn and *Jupiter*, I. 398. The shadows of *Jupiter's* Satellites observ'd I. 400. The greatest Elongations of *Jupiter's* Satellites, I. 481. An instrument for finding the distances of *Jupiter's* Satellites from his Axis, I. 404. Eclipses of *Jupiter's* Satellites observ'd, I. 407. to 423. A Theory of *Jupiter's* Satellites, I. 409. To find the Longitude by *Jupiter's* Revolution upon his Axis, I. 357.

[*Jupiter*, Occultation of a Star by him, I. 308. of the Moon 359. Eclipses of his Satellites, 309. Tables for computing their Eclipses, 313. Observations of it, 346. 355. 360, 361, 362, 363, 364. Of his Satellites, 358. Two Conjunctions with *Venus*, 363, 364.]

Ivy, the Texture of it, III. 682.

Ivy berries, a shower of them mistaken for Wheat, II. 441.

K

[A Solution of *Kepler's* Problem; I. 237]

Kermes, the grain of it, and the fly for med out of it, II. 763, 766.

A large diseased *Kidney*, with the Deadly Consequences of it, Describ'd with Figures, III. 143, to 146. A Diseased *Kidney*, III. 682.

[*Kidney*, An Ulcer in it, II. 83.]

[*Kinnardsey* in Shropshire, of the Moors or Morasses, &c. there IV. 171.]

[*Knife*, Swallowed by a Man, IV. 171.]

L

[*Lacteals*, Blue Liquors transmitted into them, II. 71.]

The *Lake* of Geneva describ'd, II. 317, 320. The *Lake* Avernus, II. 320. The *Lake* of Mexico, and some extraordinary *Lakes* in Scotland, II. 321, 322.

A *Lamb* suckled by a Weather, II. 869.

Two monstrous *Lambs*, II. 900.

Two new *Lamps* describ'd, III. 364, 365.

Perpetual *Lamps* in imitation of the Sepulchral *Lamps* of the Ancients, III. 636.

[*Land*, Of manuring it by Sea-Shells, III. 286. by Sea Sand, 289.]

Languages, Some Observations on them, III. 379.

Lapides Judaici, II. 305.

Lapis Calaminaris, II. 334.

Laryngotomia, An Argument for the use of it, III. 61, to 64.

[*Latitudes* of some of the Fixt Stars chang'd, I. 235]

Helmontian Laudanum describ'd, II. 643, 643.

Lead mines in Somersetshire, II. 573. A further account of them, II. 574, 575.

Lead Mines in Germany, II. 576.

Lead, The poysonous quality of its Ore, II. 588, 589.

Leaf Gold, a Mineral like it near Mexico, II. 588, 589.

Leach, The Stomach of it describ'd, II. 819. The Anatomy of it, II. 819, to 821. An extraordinary *Leach* that torments the Sword Fish, II. 128.

[*Leeds* a Roman Town near it, IV. 47]

[*Legions*, Roman, A Discourse of them, IV. 18.]

The *Libolla* describ'd, II. 763

Light and Colours, a new Theory of them, I. 128.

[*Light* and Colours, Experiments of them, I. [241.] of the different refrangibility of the Rays of light, I. [248.] an Attempt to produce Light through a Metallick Body in *vacuo* by Attrition, III. 173. Objects made visible in the dark, 174]

The progressive Motion of *Light*, I. 409, 410, 422.

Linnen Cloth; a new Engine to make it, I. 501.

A General INDEX of Matters.

[Of two *Liquors* which possess less space mixt, than separate, III. 171.]

A *Liver* appearing glandulous to the Eye, III. 83.

Loadstone found in Devonshire, II. 601.

Logarithms, the construction of them from the *Hyperbola*, I. 10. From the *Catena*, I.

46 The Construction of *Logarithms* by a Series of Proportionals, I. 110.

[A new way to make *Logarithms*, I. 182.]

The *Logarithmick* Curve, I. 46, 56.

Logarithmotechny, I. 1.

[*Logarithmotechny*, I. 155, & seqq.]

Longevity, and the Causes of Natural Death, III. 309, 310.

[*Longevity*, II. 152.]

Longitude; Instructions for finding it by Pendulum-Watches, I. 547. Experimented, I. 555. To find the *Longitude* by the Moon's places, I. 556. By Lunar Occultations, I. 557. By the Revolution of Jupiter upon his Axis, *ibid.* By Satellite Eclipses, *ibid.* By Lunar Eclipses, I. 300.

Longitude of Lyons, I. 562. of Lisbon, *ibid.* of Leipzig, I. 564.

[*Longitude* of Cambridge in New England, I. 286. of the Cape of Good Hope, 297. of Lima in Peru, I. 366. of the Island Virgo Gorda, *ibid.* of Nuremburg, *ibid.*]

A Globe Looking-Glass, I. 214.

Lough Neagh in Ireland, II. 322, to 324.

[*Lough-Neagh* Lake, III. 229.]

Loughs and Turloughs improv'd, II. 736.

Lumbrici Latii and *Cucurbitini*, III. 119, 120.

Lumbrici Cucurbitini found in the Kidneys of a Dog, III. 120. *Lumbricus Latii* & *Teres*; Observations upon them, with Figures, III. 121, to 132. *Lumbrici Teretes* found in an Ulcerated Ankle, III. 132. *Lumbricus Hydropicus* describ'd with Figures, III. 133, 134.

[*Luminous* Qualities of Amber, Diamonds, and Gum Lac, III. 158.]

Lungs; the Structure of them, III. 64, 65. A Polypus of them describ'd, III. 68.

[Of the motion of the Air in the *Lung*, I. 414. An Apostemation in them, II. 26.]

A new *Luni-Solar* year, and a perpetual Almanack, III. 409.

Hippocrates's *Lunula*; the Quadrature of its parts, I. 27.

Lunula; the Dimension of Solids generated by the Conversion of the *Lunula*, I. 29.

Lymphatic Vessels; the true use of them III. 262, 263.

[*Lyre* of the ancient Greeks and Romans IV. 13.]

M

Mackenboy describ'd, II. 64.

The *Macreuse* describ'd, II. 850.

The Western-shore of *Madagascar*; the Longitude of it, I. 568.

Mad-Dog; Children bit by it, III. 281, 282. Cures for *Mad-Dogs*, or any that are bit by them, III. 283. Receipts and Cures for the Bite of a *Mad-Dog*, III. 283, to 285.

Madrid; the Latitude of it, I. 562.

Maggots; an odd sort of them, II. 763.

The *Magick* Lanthorn, I. 206.

Magnetical Observations, II. 601, 602.

Magnetical Variations, near Bristol, at Paris, at Rome, at Dantzick, at Nuremburg, on the Coast of Guinea, II. 607, to 610.

Magnetical Variations predicted, II. 610. A Theory of them, II. 610, to 620.

[*Magnetical* Experiments, III. 278, 282. Observations in the *Atlantick* and *Aethiopic* Oceans, III. 285.]

Maize; the Culture and Improvement of it, II. 630, to 635, Consider'd by Mr. Ray, II. 635.

Different *Maladies*; several Observations on them, II. 288, to 290.

Malt; how to make it, II. 627, 628.

[*Man*, whether naturally carnivorous, IV. 234, & seqq.]

[*Manuscripts*, how to judge of the Age of them, IV. 1.]

Maps; a new kind of them in Basso Relievo, I. 603.

[*Map* of Variations; a defence of Dr. Halley's, III. 282.]

Marble; how to Colour it, I. 604.

[*Marble* Quarry in Iceland, III. 231. In Wales *ibid.* 232. a way to colour Marble, IV. 263.]

March. Old, Middle and Lower; Marriages, Births and Burials in them, III. 668.

Marling, Improvement of Ground by it in Suffolk, II. 731.

The parallax of *Mars*, I. 265, 224.

An Occultation of *Mars* by the Moon, An. 1676, I. 350.

A Tran-

A General INDEX of Matters.

- A Transit of the Moon below *Mars*, An. 1682, I. 357.
- The Phases and Rotation of *Mars*, I. 423.
- Places of *Mars*, observ'd, I. 424.
- [*Mars*, his Transit near a fixt Star, I. 323.]
- Observations of it, 348, 356, 360, 362, 364, 365.]
- Mary-land*; an account of it, III. 600.
- Mathematicks*; a General Scheme for the Advancement of them, I. 1.
- A Woman with a double *Matrix*, III. 205.
- [*Maxima* and *Minima*, occurring in the celestial Motions, I. 239.]
- May-dew*; Observations upon it, II. 141, 142.
- Mechanicks*, I. 457.
- Medical Observations in the North-Countries, III. 606, to 609.
- [*Medicines*, purging and vomiting, the several Doses of them, II. 193.]
- Melons*; how to be order'd, II. 638, to 640.
- Memory*; the Strength of it, III. 661.
- [*Menses*. A Woman that had them regularly at 70 Years of Age, II. 622.]
- Menstrua*; why bodies Swim that are dissolv'd in such as are specifically lighter, I. 535.
- The Visible Conjunctions of *Mercury* with the Sun, I. 427.
- Mercury* observed in the Sun, An. 1690. I. 426. An. 1697. I. 427.
- Mercury* found in Plants, II. 580. The Incalcescence of it with Gold, II. 580, to 583. The use of it in separating Silver from the Ore, II. 589, to 591.
- Dog-Mercury*; the mischievous effects of it, II. 640.
- [*Meridian*; an Instrument to find it in any place, I. 228. To see the Sun and Stars pass it, *ibid.*]
- Meridian-line*; the true Division of it, by a Collection of Secants, I. 572.
- The Analogy of the Logarithmick Tangents with the true *Meridian-line*, I. 576. Demonstrated, I. 577.
- A new *First-Meridian* propos'd, I. 546.
- A suppos'd Alteration of the *Meridian-line*, I. 265.
- [Of drawing a *Meridian-line* through France, I. 424. Several ways of drawing one, I. 225.]
- [To divide the Nautical *Meridian line*, mechanically, I. 425.]
- Metal*; how to make it run smooth and close, II. 557.
- [*Metals*. Experiments on several, with a large burning Glafs, III. 241.]
- An unusual *Meteor*, II. 200.
- [Accounts of several *Meteors*, III. 138. One seen all over England, 141. One in Jamaica, III. 148.]
- A Mexican *Musk-hog*, II. 873. to 880.
- Mexico*; Observations in it, III. 565.
- Micrometers*; I. 217, to 220.
- [How to use the *Micrometer* in Solar Observations, I. 249.]
- Microscopes* of several Inventions, I. 207.
- [Remarks upon *Microscopes*, I. [250.]
- The way to make them, I. [251.]
- A Water-*Microscope*, I. 209.
- Microscopes* improv'd by illuminating the Objects with uncompoundd Light, I. 210.
- Reflecting *Microscopes*, I. 210.
- A *Microscopical Animal* discover'd, III. 650.
- Microscopical Observations*, III. 650, to 653.
- [*Microscopical Observations*, IV. 250.]
- Microscopical Animals* observ'd, II. 653. 654.
- Mills*; Horizontal Sails for them, I. 498.
- Mines*; Air in them, II. 372. How to work in *Mines* without Air-Shafts, II. 372, 373. Damps in them, II. 373, 374, to 382.
- Mineral Maps*, II. 450, 451.
- Mineral Springs* about Paderborne in Germany, and at Basil, II. 331, 332. Near Yeoville in Somersetshire, on the Malvern in Herefordshire, at Farrington in Dorsetshire, in the Bishoprick of Durham, in Glamorgan-shire, at Eglington in Northumberland, II. 332, 333. At St. Amand near Tournay, II. 334, 335.
- Mineral-Waters* in Jamaica, II. 344, 345.
- A *Mineral Balsom* in Alsatia and Italy, II. 460, 461.
- A *Mineral Juice*, II. 459.
- A *Mineral* at Liege, yielding Brimstone and Vitriol, II. 530, 531.
- [A *Mineral-Water* near Canterbury, III. 217.]
- [Accounts of *Mineral Waters*, *ibid.* & seqq.]
- Certain *Mineral-Glebes*; their Efflorescence, II. 548, 549.

A General INDEX of Matters.

Miscellaneous Experiments, III. 656, 657.
 A sort of *Miffelice* in Jamaica, II. 669, to 672.
 The *Modulations* of the Voice; a Conjecture about them, III. 61.
Monochord; the true division of it, I. 601.
 A *Monstrous* Birth like a Monkey, III. 301.
 A *Monstrous* Boy and Child described, III. 304.
 [*Monstrous Births*, II. 152.]
 An Ancient *Monument* at Foultham in Norfolk, III. 436.
Moon; Diameters of it, I. 217. how to measure the *Moon's* Parallax, *ibid.* To find the Longitude by the *Moon's* Occultation of fixt Stars, I. 547.
 Changes likely to be discover'd in the *Moon*, I. 398.
 To find the Parallax of the *Moon*, I. 300.
 Directions for observing Eclipses of the *Moon*, I. 300.
 Eclipses of the *Moon*, An. 1665. I. 304. An. 1666. I. 304. An. 1670. I. 304. An. 1671. I. 306. An. 1675. I. 308, 314, 316. An. 1678. I. 320. An. 1681. I. 324. An. 1682. I. 326. An. 1684. I. 334. An. 1685. I. 335. An. 1686. I. 339. An. 1688. I. 339. An. 1697. I. 340.
 [Eclipses of the *Moon*, I. 283, 365. Observations of it, 351, 357, 365.]
Moon; A Transit of the *Moon* above Venus, An. 1670. I. 347. An Occultation of Saturn by the *Moon*, An. 1671. I. 347. An. 1678. I. 353. A Transit of the *Moon* above Jupiter, An. 1671. I. 347. An. 1676. I. 350. An Occultation of the Pleiades by the *Moon*, An. 1672. I. 348.
 A Transit of the *Moon* near the Northern Horn of Taurus, An. 1673. I. 349.
 An Occultation of a fixt Star in Leo by the *Moon*, An. 1676. I. 349.
 An Occultation of Jupiter by the *Moon*, An. 1679. I. 353. An. 1686. I. 359, 364.
 Occultations of the Bulls-eye by the *Moon*, An. 1680. I. 355. An. 1681. I. 356.
 A Transit of the *Moon* below the three Superior Planets, and Regulus, An. 1682. I. 357.
 Occultations of Regulus by the *Moon*, An. 1683. I. 357, 359.
 Occultation of two Stars in Taurus by the *Moon*, An. 1683. I. 359.

Occultation of a Star in Cancer by the *Moon*, An. 1683. I. 365.
 Occultation of Saturn by the *Moon*, An. 1687. I. 365.
 The General Bills of Mortality in London, II. 685.
 [*Mosaic Work* at Leicester, IV. 79.]
Mosco; the Longitude and Latitude of it, I. 564.
 [*Mosses* in Scotland, III. 272.]
Muscovy; Latitudes of several places in it, I. 564.
Motion; the Air's Resistance to it, I. 484.
 The General Laws of *Motion*, I. 457.
 [*Motion* of a stretch'd String, I. 53.]
 [*Mouldiness* in a Melon, III. 298.]
 [*Mountain Hen* dissected, III. 338.]
Mulberry-Trees; an unusual way of propagating them in Virginia for the Silk-work, II. 653.
 A *Murren* in Switzerland, and its Cure, II. 869, 870.
Muscadine-Wine; the way of making it, II. 657.
 The *Musca-lupus* in Virginia, II. 786.
 The *Muscles* and Joints; Mr. Clarke the Posture-Master had an absolute command of them, III. 297, 298.
Mushroom; an odd kind of it, II. 623, 624. another sort of it, *ibid.* The flowers and seeds of Mushrooms, *ibid.*
Musick, I. 606. Ancient and Modern *Musick* compar'd, I. 618.
Musical Instruments; the Trembling of the Strings of them, I. 606.
 [The Theory of *Musick* reduc'd to Arithmetical and Geometrical Proportions, I. 429.]
 A Mexican *Musk-Hog*, with figures explain'd, II. 873, to 881.
 The *Musk Quash* described, II. 873.
 To raise an Infinite *Multinomial*, I. 90.
 [*Myopes*. How they may use Telescopes, without Eye Glasses, I. [252].]

N

 The *Natron* of Egypt and Nitrian Water-examin'd, II. 525, to 532.
Navigation, I. 546.
Navigation; What a Compleat Treatise of it should contain, I. 571.
 [*Nautical Meridian Line*: how to divide it mechanically, I. 425.]

[*Nebula*

A General INDEX of Matters.

[*Nebula* amongst the Fixt Stars, I. 234.]
A Nebulose Star Discover'd, I. 247.
 [Neck, a large Tumor in it, II. 21. one full of Hydatides, 24.]
A Negro Boy dappled with white spots, III. 8.
Negropont, the Latitude of it, I. 564.
Needle, the respect of it to a piece of Iron, held perpendicular in several Climates, II. 602.
 The Declination of it observ'd, II. 607.
 [Optick Nerve distemper'd II. 13.]
New Caledonia in Darien; A Voyage to it, III. 561. to 564.
New-England, Observations in it. III. 564, 565.
New-England Rarities, III. 546.
A New Stove, the success of it, II. 750.
Nitre of Egypt, the Original of it, II. 529.
Nitre, the way of preparing the Compound Spirit of it, III. 359, to 364.
 The North-East Passage, a Summary Relation of the discoveries about it, III. 610, to 614.
 The North-East Passage, I. 570. III. 610.
 The North-Isles of Scotland; Observations upon them, III. 543.
Nose, the structure of it describ'd, III. 56, 57.
Numeral Figures; the Antiquity of them in Europe, I. 107, 108.
Nuremberg, the Latitude of it, I. 563.
Nux Pepisa, or *Faba Sti. Ignatii*, II. 648, to 652.

O

Oak prepar'd for Tanning, II. 668.
A Dwarf Oak from New-England, II. 669.
 The Obelisks at Burrow-Briggs, not Artificial, but Natural Stones, with other Antiquities, III. 417.
 Several Observables in Lincolnshire, III. 533, to 537. at Chester, III. 537.
Observatory at Paris; a deep Cave in it, II. 2.
 The Situation of the Observatory of Tycho Brahe, I. 216.
Oesfridge, Observations on the Dissection of it, II. 857, to 860.
 An Old Earthen Vessel found near York, III. 419.
Oakey-hole, and some other Subterraneous Caverns, in Mendip-hills, describ'd, II. 368, 369.

Opal; how to counterfeit it, III. 658.
Opium; the use of it among the Turks, II. 643, 644.
 [Opium, A great quantity of it taken without causing Sleep I. 192.]
Opossum, the Anatomy of it, with the Figures of its several parts explain'd, II. 881, to 898.
 [Dissection of a Male Opossum, III. 324.]
Opticks, I. 128.
 An Optical Experiment, wherein a Needle appears inverted, when applied to the Eye, before a small hole in a Paper, I. 172.
 An Optical Problem of Alhazen solv'd several ways. I. 172.
 To find the principal Foci of Optic Glasses universally, I. 183.
 To grind Hyperbolical Optick Glasses, I. 189.
Optick Glasses of small Spheres, collecting the Rays at a great distance. I. 193.
Optick Lens's of Rock-Chrystal, I. 195.
Optick Lens's of Water, I. ibid.
 The Advantages of Reflection in Optick Instruments, I. 196.
Optick-Glasses Ground by a Turn-lathe, I. 215. On a Plain, Ibid.
Opticks, A Spherico-Catoptrick Theorem, I. [237.]
Orange-Trees, how to keep them in Winter without Fire, II. 658.
Orange-Trees, at Florence, bearing Fruit, which is Citron on one side, and Orange on the other, II. 658, 659.
Organ, the imperfection of one, I. 612.
 An Os Frontis in the Medicine-School at Leyden, prodigiously large, with Figures III. 2 to 8.
Osteo-colla about Frankfort on the Oder, II. 641.
Ostracites, The Virtues of them, II. 505, to 507.
Ova found in a Cow, III. 904. *Ova* after a second Conception dispers'd in the Abdomen of a Birch, though the Cornua Uteri were fill'd with the Bones and Flesh of a former Conception, II. 904, to 907.
Oxford, the Longitude of it, I. 560.
Oysters, a sort of them in East India, II. 826. Shining Worms in them, II. 826, 827.

A General INDEX of Matters.

P

Painting, I. 598.
 [A mans temper may be judg'd of by his performances in *Painting*, IV. 7.]
 [Of the Root of *Pareira Brava*, III. 301.]
 The *Parenchymous* parts of the Body describ'd, III. 17, to 20.
Parbelia observ'd in France, in Hungary, at Dantzick, at Marienburg, in Borussia; in Suffolk, at Canterbury, II. 186, to 188.
 [*Parbelia*, and other appearances in the Atmosphere, III. 111. & seqq.]
Paris; the Longitude of it, I. 560, 562.
Paroquet; Observations on the dissection of it, and the figures of its parts explain'd, II. 855, 856.
 Thomas *Parre*; an account of him, III. 306, 307.
Patras; the Latitude of it, I. 568.
Pau; the Longitude and Latitude of it, I. 562.
 [*Pavement*, an ancient Tessellated one, IV. 79.]
Pearl the Origine of it, II. 827. *Pearl-fishing* in Ireland, II. 828, 829.
Pebbles transparent, II. 466, 467.
Peculiarities both in Men and Brutes; divers Instances of them, III. 287, 288.
Pekin; the Longitude and Latitude of it, I. 569.
Pendulum; Synchronism of the Vibrations of it in a Cycloide, I. 462.
Pendulum-Watches, I. 465.
Pen-Park Hole in Gloucestershire, II. 370, 371.
 A Strange *Pericardium* describ'd, III. 69.
 A *Periodical Palsy* describ'd, III. 33, 34.
 A mistaken *Perpetual Motion*, I. 505.
Persepolis; the Ruines of it, III. 527.
Perspective. I. 598. A *Perspective Instrument*, *Ibid*.
 [*Pewter Money* coin'd in Ireland, IV. 231.]
Pheasants and *Partridges*; how to breed them up, II. 852, 853.
 [*Philippine Islands* discover'd, IV. 191.]
Philosophy; the present languid State of it, II. 2.
 [*Phanicopter*; Its natural History and Description, III. 364.]
Phonicks compar'd with *Opticks*, I. 508.
 The *Bononian Phosphorus* lost, III. 346.
 A *Phosphorus* by Mr. Boyle, III. 346. Mr.

Kunkel's *Phosphorus*, III. 347. Experiments with the liquid and solid *Phosphorus*, III. 347, to 350. A Parallel betwixt a *Phosphorus* and *Lightning*, III. 350, 351.
 The *Phosphorus Metallorum*, III. 682.
Pictures; an Examen of them, I. 603.
 A monstrous *Pig*, II. 900. Two monstrous *Pigs*, II. 900, 901.
Pismires; the Acid Juice of them, II. 791.
 A *Pistol-bullet* crufted over, voided by *Urine*, III. 164.
Pitch, *Tar*, *Rosin*, and *Turpentine*, the way of making them, II. 669.
Plagus, an Experiment concerning it, III. 274, 275. A Preservative against the Infection of it, 275.
 [*Plague* at Copenhagen, II. 189.]
Planets; the Proportion of Light wherewith they are illuminated, I. 280.
 To find the *Aphelia* of the *Planets* directly, I. 253.
Plants; how to preserve the Specimens of them, II. 623.
 [*Plants*; of the parts and use of the flower in them, III. 293. Accounts of several 300. & seqq.]
 [*Plants* in *Wales*, *Scotland*, and *Ireland*, IV. 138. & seqq.]
 [*Play*; Of the Chances in Games, I. 190.]
 The *Pleiades* observ'd, I. 245.
 The Occultation of the *Pleiades*, An. 1672, L. 348.
Pneumatical Experiments upon Ducks and Vipers, Frogs and Kittlings, II. 215, to 217. Upon several liquors and the mixtures of them, and upon several Plants, Fruits and Flowers, II. 235, to 251. A *Pneumatical* Experiment of a Bladder included in an exhausted Receiver, II. 251.
 The *Pneumatick Engine* applied to Cupping Glasses, III. 265, 266.
 [Of the proportion of Mathematical Points to each other, I. 56.]
Pole; the Elevation of the *Pole*, and the obliquity of the *Ecliptick* continue unalter'd, I. 263.
 The *Polarity* of Iron, II. 603, to 606.
Polypus; the Original of it, III. 57, 58.
 A *Polypus* in the Heart, III. 70. The cause and nature of a *Polypus*, III. 71, to 76.
 Horned *Poppy*, describ'd, II. 642.
 The *Pores* of the Skin described with
 X x x figures,

A General INDEX of Matters.

figures, III. 9. 10. Wholly obstructed by Nocturnal Air, III. 10.
Porpess; Observations on the Anatomy of it, II. 839. to 842. A Venomous scratch with the Tooth of a *Porpess*, II. 842.
Porphyry Pillars in Egypt; an account of them with figures, III. 528. to 530.
Portland, an account of the Damage that hapned there, February 3. 169 $\frac{1}{2}$. III. 649.
 To raise the Powers of an Infinite Multinomial, I. 90.
Poysons; Observations on them, II. 814. to 816.
 [*Poysons*; Experiments of them on several Animals, II. 217.]
 A *Poisonous Fish* about the Bahama Islands, II. 842.
 The *Preparing Vessels*; an extraordinary situation of them, III. 191.
Universal Primer; an Essay towards it, III. 378.
 [*Printing*. Of its Invention and Improvement, IV. 216.]
 [*Problems*; Solution of several, I. 42.]
 The effects of Gravity on the Motion of *Projects*, I. 472.
 The Doctrine of *Projects*, I. 475.
 The Resistance of the Air to the Motion of *Projects*, I. 484.
 An Account of *Prusa* in Bithynia, and the Observations in Turkey continued, III. 473. to 489.
 [*Pulmonalis vena*; a Polypus taken thence, II. 33. An Account of the Structure of that Vessel *ibid.*]
 A cheap Pump, I. 545.
 [A Puppy in the Womb, that received no nourishment by the Mouth, II. 39.]
 [*Purgatives*; Of the principles of them, II. 206.]
 The *Purple-fish* Describ'd, II. 822. to 825.
 The *Pyrites* and *Lapis Calcarinus* consider'd, II. 529. The spontaneous firing of the *Pyrites*, II. 520.
 [*Pyrmont Waters*; their Virtues and Qualities, III. 222.]

Q

The *Testudo Veliformis Quadrabilis*, I.

The *Quadrable Spaces* in a Cycloide, I. 116.
 A *Quadratrix* to a Circle, I. 56.
 [A *Quadratrix* to the Hyperbola, I. 23.]
 The *Quadrature* of the parts of Hippocrates's *Lunula*, I. 27.
 The *Quadrature* of a portion of the Epicycloid, I. 31.
 The *Quadrature* of Figures Geometrically Irrational, I. 52.
 The *Quadrature* of the Logarithmic Curve, I. 56.
 [*Quadrature* of Curves, I. 5. Of Curvilinear Figures, 17.]
Quarries and Rocks, in Austria and Hungary, II. 464.
 A Quarry of White-Marble in Ireland, II. 464.
Quick-silver-Mines in Friuli, II. 579. 580.

R

The *Rail* describ'd, II. 853.
Rain falling; to measure the quantity of it, II. 44. to 46. The *Rain* at Gresham-Colledge London, in 1695, 1696, II. 60. at Townley, in 1697, 1698, II. 86. A Freezing *Rain* in Somersetshire, II. 150. at Oxford, II. 152.
 [*Rain* at Zurich and Upminster, III. 13. at Upminster and Paris, 93.]
Rainbows observed in France, at London, and at Chester, II. 188, 189. Optical Assertions concerning the *Rainbow*, II. 194. The Colours and Diameter of the *Rainbow* from the given Proportional of Refraction; And the contrary, II. 195. to 199.
 [*Rainbow Lunar* seen in Darbyshire, III. 149. Of Marine Iris's, III. 150.]
Rat; Observations on the dissection of it, II. 871.
Rattle-snake; the Anatomy of it, with many Figures, II. 797. to 809. A way of killing it, II. 811.
 [*Rattle-snakes* in New England; III. 375.]
 The exhausted *Receiver*; the production and growth of Animals in it, II. 227. The expansion of Blood and other Animal juices in it, II. 228. Experiments about Snails, Bats and Leeches in it, II. 232. about creeping.

A General INDEX of Matters.

ing and winged Insects, Ants, and Mites, how long they live in it, II. 233, 234.

Refining; the Art of it, giving an account of the separation of all other Bodies from Gold and Silver, 1. by Parting, 2. by the Test, 3. by the Almond Furnace, or the Sweep; and 4 by Mercury, II. 591, to 595. Experiments of *Refining* Gold with Antimony, II. 595, to 599.

The Apertures and Charges of *Reflecting* Telescopes, I. 200.

Maps in low *Relievo*, I. 603.

Reflecting Telescopes, I. 210.

Reflecting Microscopes, I. 210.

To find the Point of *Reflection* in Speculums, I. 172.

The Advantages of *Reflection* apply'd to Optick Instruments, I. 196.

The *Reflective* Power of the Superficies of Fluids contiguous to other Fluids, I. 526.

[*Refractions* of Fluids, the Apparatus to make Experiments on them, III. 169.]

Remedies suggested against Cold, III. 639.

Respiration; Difficult at the tops of Mountains, II. 226.

Rey; a strange sort of it in France described, II. 625, 626.

The *River* Greatah running under Ground, II. 325. *River-water* recover'd after stinking, II. 326.

Hard *Rock*; how to break them, II. 368.

[*Rocks*. Two strange ones in New-England, IV. 112.]

Roman Urns and other Antiquities near York, III. 415, 416. A *Roman* Pottery near Leeds, III. 418. *Roman* Bricks and Plaistering, III. 419. An old *Roman* Wall, and Multangular Tower near York, III. 419, 420. Several *Roman* Antiquities about York, and Leeds, III. 421. A *Roman* Coffin and other *Roman* Antiquities and Coins, III. 421, 422. A *Roman* Pavement near Roxby in Lincolnshire, III. 422, 423. A *Roman* Altar near Shields in the Bishoprick of Durham, III. 423, 424. Two *Roman* Altars with their Inscriptions in Northumberland, III. 424, 425. A *Roman* Altar with its Inscription, III. 425, 426. Some *Roman* Coins found near Nottingham, III. 426. Molds for Coining or

Counterfeiting *Roman* Coins, with a *Roman* Shield, III. 426, 427. The *Roman* Way call'd Highstreet in Lincolnshire, III. 428, to 430.

[*Roman* Sudatory in Shropshire, IV. 67.]

Roses; the Longitude and Latitude of it, I. 562.

[*Royal Oak*; an Inscription on it. IV. 137.]

Rubricks for the Seat of Easter according to the Julian Account, explain'd, II. 402, 403.

A *Ruminating* Man; an account of him, III. 110, 111.

Runick Inscriptions, III. 433, 434. A *Runick* Inscription on the Font at Bridekirk, III. 435.

Turkish Rufina, II. 458.

The Latitude of several places in *Russia*, I. 564.

A *Rusty* Needle breaking out at the side, III. 93.

S

Sable Mice describ'd, II. 871, 872.

Saffron; the Culture of it, II. 635, to 638.

A Ship *Sailing* against the Wind, I. 577.

Horizontal *Sails* for Mills, I. 498.

A *Salamander* described, II. 816.

Sal-Gemme Mines in Poland, II. 524.

A new *Salival* Duct discover'd and described, III. 58, 59.

Salt; the way of making it in France, Lancashire, and Germany, II. 363, to 365.

Salt and Sand form'd from Brine, II. 360, 361.

Salt-Springs at Hall in Saxony, and at Lunenburg, in Dorsetshire, and the Bishoprick of Durham, II. 351. *Salt-Springs* and *Salt-making* at Nantwich in Cheshire and at Droitwich in Worcestershire, II. 352, to 360.

Salt-Mines in Transylvania and Hungary, II. 523.

Natural *Salt*, a Rock of it in Cheshire, II. 523.

An odd *Salt* extracted out of a Metallick substance, II. 325. A Volatile *Salt* ex-

X x x x 2

tracted

A General INDEX of Matters.

tracted out of all sorts of Plants, III. 326, to 328. No Alcalizate Salt in any Subject before the Action of Fire upon it, III. 328, to 331. No sensible Difference among fix'd and Volatile Salts, and Vinous Spirits, III. 331, to 339. Vegetable Salts extracted, III. 339, to 344. The quantity of Volatile Acid Salts, contain'd in Acid Spirits, III. 344, 345.

[Saltiness of the Ocean, the cause of it, III. 208.]

Salvadore in Brasil; the Latitude of it, I. 570.

Sands; Schemes of them, II. 451, to 454.

A Sand-Flood at Downham in Suffok, II. 455, 456.

A black Shining Sand from Virginia examined, II. 556, 557. A black Sand from Italy, II. 557.

A Sandy Soil manur'd with Clay, II. 731.

Sap; the Circulation of it, II. 689. The descent of it in Winter, II. 690.

[Satellites; see Saturn and Jupiter.]

Satellites of Jupiter; to find the longitude by them, I. 557. Particularly of the First, I. 559. The Shadows of the Satellites of Jupiter observ'd, I. 400. The greatest Elongations of the Satellites of Jupiter, I. 401. An Instrument showing the distances of the Satellites of Jupiter from his Axis, I. 404.

Satellite Eclipses observ'd, I. 407, 409, 421, 422, 423.

A Theory of Jupiter's Satellites, I. 409.

The places of Saturn observ'd, I. 367. The outermost Satellite of Saturn discover'd, *ibid.* The 3d Satellite of Saturn discover'd, I. 369. The two Interior Satellites of Saturn discover'd, *ibid.* The Theory of the Five Satellites of Saturn, I. 370.

The Conjunctions of Saturn and Jupiter, An. 1682, and 1683. I. 389.

A Table of the Mean Conjunctions of Jupiter and Saturn, I. 398.

An Occultation of Saturn, An. 1671, I. 347. An. 1678, I. 353. An. 1687, I. 365.

A Transit of the Moon below Saturn, An. 1656 I. 337.

The Phases of Saturn, An. 1665, I. 365. An. 1666, I. 365; An. 1668, I. 363. An.

1670, I. 365. An. 1671, I. 366. An. 1675, I. 366. An. 1676, I. 367.

[Saturn; Observations of it, I. 343, 353, 360, 361, 362, 363, 364, 365. The motion of his Satellites rectified, I. 298. Tables of their motion, 303.]

A Piece of Saxon Antiquity found in Somersetshire, II. 441, 442. Some Saxon Coins found in Suffolk, III. 436, 437. Remarks upon them, and an Addition to them, II. 438, to 441.

Scale-Fish; Experiments about it in an exhausted Receiver, II. 220, 221.

Scallop; The Anatomy of it, II. 829, 830.

Scolopendra Marina, II. 833, to 836. The Figures of it explained, II. 836.

Scotland; Observables in it by several Persons, III. 538, to 540.

[Scotland; Remarkables there, IV. 143.]

[Skull, Fracture in it, II. 13.]

Sculpture, I. 598.

[Scurvy; Strange Effects of it, II. 13]

Sea; The depth of it sounded without a Line, II. 257, to 260. How to fetch up Water from any depth of it, II. 260. The Flux and-Reflux of the Sea; an Hypothesis about it, II. 268, to 276. Objections against this Hypothesis answered, II. 276, to 278. Animadversions on this Hypothesis, answered by Dr. Wallis, II. 279, to 284.

Sea Water; The differing Gravities of it according to the Climates, II. 297. A way to make Sea Water Sweet, *ibid.*

Sea Water made fresh, II. 297, 298.

An Inland Sea near Dantzick, yielding a poysonous substance, II. 320.

The Collection of Secants, I. 572.

[Of Secretions in an Animal Body, II. 157.]

Seeds which clarify Water, II. 646.

A strangely Self-moving Liquor, III. 367, to 369.

The Spanish Sembrador its Uses, II. 738, to 741.

An ancient Sepulchre found in France, and the Verbal Process upon the discovery of it, III. 443, to 446. An ancient Sepulchre near Rome, III. 448.

[Series's infinite; A Discourse of them, I. 88. A Problem of Chance solv'd by the help of them, I. 327.]

Serpent;

A General INDEX of Matters.

- Serpent*; Symptoms attending the bite of it, and a Stone healing it, II. 813, 814.
- Seville*; The Longitude of it, I. 563.
- [*Sheep*; Of Worms found in their Heads, III. 348. *Hydatides* in the Kidney of one, 349.]
- A *Shell* found in the Kidney, III. 162.
- [*Shells* found under-ground in Northamptonshire, III. 258.]
- Shell Snails*; The odd Turn of some of them, II. 822.
- Shell-Fish*; Experiments about them in an Exhausted Receiver, II. 220, 221.
- [A curious *Shell-Fish* found in *Edinburgh Frith*, III. 381.]
- Shining-Fish*; Observations on it, III. 639, 640. And on *Shining Fish*, III. 641, to 645.
- Shining-Wood* and *Fish*, Experiments concerning the relation of Light and Air in them, II. 206.
- To preserve *Ships* from being Worm-eaten, I. 596.
- Lead-Sheatings* for *Ships*, I. 596.
- Ship-building*, I. 588.
- The Art of *Shooting Bombs*, I. 471.
- Shooting* by the Rarefaction of the Air, I. 496.
- A help to *Shortsightedness*, I. 207.
- Sight* decayed; an easy help to it, III. 41.
- Plain *Sights* rejected, I. 220. Preferred to *Telescopic Sights*, I. 221.
- Silk*; The nature and qualities of it, II. 757. How to know the best *Silk*, and estimate it by Essay, II. 757.
- The *Silk-Tail* described, II. 853.
- Silk-Worms*; Observations about ordering of them, II. 756.
- [*Silk* of *Spiders*, III. 382. Of *Silk-Worms*, 386.]
- Silver-Mines* in Hungary, II. 583, to 585. Vegetable *Silver*, II. 591.
- Silver-Pine*, from the Cape of Good Hope, II. 672.
- Siphons* performing the same things with the *Sipho Wurtembergicus*, I. 537.
- The choice and charge of *Slate*, I. 588.
- [*Sleepy Person*, II. 167.]
- [*Small Pox* procured by Infection, II. 176.]
- [*Smalt* and *Arsenick*, of their preparation, III. 262.]
- Smoke*; An Engine consuming it, III. 638.
- Snake Root*; described, II. 644, 645.
- Snow*; An unusual sort of it, II. 148.
- Red *Snow* near Geneva, *ibid.* Observations upon *Snow*, *ibid.* The Nature of *Snow*, II. 148, to 150.
- [A Woman that lay 6 Days covered with *Snow*, II. 186.]
- Snow-down-Hill*; An account of it, III. 537.
- Soap-Earth*, from Smyrna, II. 457, 458.
- The *Solar Numbers* corrected, I. 269.
- Solar Eclipses*, An. 1666, I. 280. An. 1675. I. 284. An. 1676, *ibid.* An. 1684, I. 291. An. 1687. I. 296. An. 1699. I. 297.
- [*Solid* of least Resistance, I. 39.]
- The *Sorbus Pyriformis*, II. 652, 653.
- The Swiftness of *Sound* and its Reflection or Eccho, I. 506.
- The Doctrine of *Sounds*, I. 508.
- [*Sound*, Experiments of it, I. 374. 400. Its Nature and Properties, 392.]
- [*Spain*; Of Insects and Marine Animals, there, III. 396.]
- Spar*; The growth of it, and the formation of Rock-Plants, II. 519, to 523.
- Sparta*, the Latitude of it, I. 564.
- [*Spasmus*; an unusual one, II. 164.]
- [*Spaw-Waters*; an Examen. of them, III. 219.]
- A *Speaking Trumpet*, I. 505.
- An Instrument for measuring *Specifick Gravity*, I. 516.
- The *Specifick Gravity* of several Bodies, I. 523.
- The *Aereal Speculum*, I. 172.
- The Point of Reflection in a *Speculum*, found several Ways, I. 172.
- The Proportion of *Spheres* to their containing Cylinders, I. 58.
- Spiders*; a Table of them, found in England, II. 793, 794.
- Spiders*; darting their Threads into the Air, and swimming in it, II. 794, to 796.
- The Innoxiousness of them and Loads, II. 795. They tinge Water of a Sky Colour, *ibid.*

Spiders;

A General INDEX of Matters.

[*Spiders*; Of their Silk, III. 382.]
Spleen; the Texture and Use of it, with Observations about it and the Liver, III. 84. A diseased *Spleen*, and a Polypus near it III. 85. A Bitch with Puppy that had lost the *Spleen*, II. 904.

[Of the Glands in the *Spleen*, II. 39. Observations of it, II. 40.]

A *Spout* at Topsham near Exeter, II. 104.

[*Spouts* in the Downs, III. 210. in the Mediterranean, III. 211. in Yorkshire, 213. in Lancashire, 215.]

A *Spring* that is never frozen, II. 335.

[A burning *Spring* in Shropshire, III. 216.]

A new Sort of *Stairs*, I. 596.

Fixt Stars; how to find the Parallax of them, I. 231. The distance of them, I. 233. The places of 23 of the chiefest of them, according to the ancient Astronomers, I. 234.

The Distances of some of the chief *Fixt Stars*, as observ'd by the Ancients, I. 243.

The Motion of the *Fixt Stars*, I. 245.

The *Nebulose Stars* discover'd, I. 247, 251.

The first of Aries a double *Star*, I. 247.

Changes observed among the *Fixt Stars*, I. 247.

New *Stars*, *ibid.*

To find the Right Ascension and Declination of an unknown *Star*, I. 62.

[*Fixt Stars*; a new one in the Swan's Neck, I. 231.]

[Change of Latitude of some of them, I. 235.]

[History of new ones, I. 232.]

To Cast *Statues* of an extraordinary Thinness, I. 599.

Steel; a new Way of making it, II. 560, to 562.

A *Stellar-Fish*, II. 832, 833.

A Property of the *Stereographick Projection*, demonstrated, I. 577.

Stomach and Guts; the Motion of them. I. 91. The *Stomach* of a Horse wounded, and the Cure of it, *ibid.* A Knife cut out of the *Stomach*, *ibid.*

Stones in the Gall Bladder and conjoyn'd Kidneys, with Figures, III. 81, 82.

A *Stone* taken from a Woman, III. 149. Many *Stones* taken from one Bladder, *ibid.* *Stones* found in the Kidneys, III. 150. Large *Stones* voided by a Woman, *ibid.* A *Stone* taken out of the Bladder weighing 32 Ounces; Two large and oddly shap'd *Stones* found in the Kidneys, and a very great *Stone* taken out of the Bladder, *ibid.* *Stones* voided *per penem*, III. 151. A large *Stone* voided by a Woman, *ibid.* An extraordinary *Stone* found in the Kidney, III. 151, 152. Two *Stones* lodg'd 20 Years in the *Meatus Urinarius*, III. 153. A prodigious *Stone* in the Bladder, weighing about 51 Ounces, III. 154. A *Stone* cut from the Bladder that adher'd to it, *ibid.* Several *Stones* voided by a Boy in Scotland, III. 154. The Cheat of these *Stones* discover'd, III. 155. Broken *Stones* voided, *ibid.* A *Stone* cut out from under the Tongue, III. 156. A *Stone* in the *Glandula Pinealis*, III. 157. *Stones* found in the Heart and Lungs, III. 158. *Stones* found in the Gall-Bladder, Stomach and Kidney, III. 159. *Stones* voided by Siege, III. 160. A *Stone* grown to an Iron Bodkin in the Bladder, III. 162, 163. A *Stone* from the Bladder, with a Flint in it, III. 164. A *Stone* from the Bladder with Hair growing on it, *ibid.* A *Stone* in the Bladder of a Dog, *ibid.* A *Stone* fastened to the Backbone of a Horse, III. 164, 165. A *Stone* taken out of the Belly of a Horse, III. 165, 166. A *Stone* in the Bladder of an Ox, III. 166, 167. A prodigious number of *Stones* voided by a Woman at Bern, III. 167. to 176. Two of these *Stones* examined, III. 176, 177. The Production of *Stones* in Animals, III. 178, to 181. Comparative Experiments about *Stones*, III. 181, 182. The Generation of the *Stone*, III. 182. *Stones* extracted from Women without Cutting, with Figures, III. 182, 185. A large *Stone* cut from a Woman, *ibid.* A new Way of Cutting for the *Stone*, III. 185, 186. Observations and Experiments concerning this Way of Operation, III. 187, 188. The Way of Cutting for the *Stone* in the Kidneys, III. 188, to 191.

[*Stems*, a Plant good against it, III. 300.]

Stones in several Animals much esteem'd,

A General INDEX of Matters:

- ed, but of little Use in Physick, III. 315.
- Swallowing of *Stones* the Cause of a Disease, III. 92. Remarks on it, III. 93.
- Prune *Stones* breaking out of the Navel, *ibid.*
- [Cases of Persons swallowing *Stones*, II. 99. Several voided, 103.]
- Stones* fit for Building, I. 588.
- A blackish *Stone* in Shropshire, yielding Pitch, Tar and Oyl, II. 459. 460.
- Stones* not grown to Maturity in Scotland, II. 463.
- A *Stone-Quarry*, near Maestricht, II. 463.
- Stones* growing at the End of a Rush, II. 464.
- Stones*; Several of them regularly figured, II. 507, to 511.
- A Tincture given to a *Stone*, I. 604.
- [A *Skeleton* imprest upon a *Stone*, IV. 61.
- Curious *Stones* in *Wales*, *Scotland*, and *Ireland*, 138. & *seqq.*]
- [*Stool* and *Urine*. Balls and other Bodies evacuated that way, II. 106. 108. & *seqq.*]
- [*Storm* in Nov. 1703. III. 94. 97. Several of Thunder and Lightning, II. 150. & *seqq.*]
- Strasburg*, the Longitude of it, I. 562.
- Colebatch's *Syrpicks*; Experiments made with it, III. 255.
- [*Styrax Liquida*, how to make it, II. 226.]
- [*Subsiding* of Three Oaks, III. 312.]
- A *Subterraneous Fire* in a Coal-Mine near New-Castle, II. 383, 384.
- Subterraneous Oaks* in Somersetshire, II. 423.
- [*Sudatory*, a Roman one in Shropshire, IV. 67.]
- Sugar*; an extraordinary spirit of it, II. 635.
- [*Sugar*; Its Virtues and Properties, III. 311.]
- Sun*; the Parallax of it, I. 265, 424.
- [*Sun*; A new way to find its Parallax, I. 243.]
- Tycho's Equation of the *Sun's Orb* too great, I. 269.
- Spots in the *Sun*, An. 1660, I. 274. An. 1671, *ib.* An. 1676, I. 277. An. 1684, I. 279.
- [Spots in the *Sun*, I. 249.]
- Eclipses of the *Sun*, how to be observ'd, I. 280.
- [Eclipses of the *Sun*, I. 264, 366.]
- [*Solar Observations* I. 350.]
- [*Sunk Island* in *Humber*, IV. 154.]
- Mercury observ'd in the *Sun*, I. 426.
- The visible Conjunctions of Mercury and Venus with the *Sun*, I. 427.
- The Diameters of the *Sun*, I. 217.
- Surveying*, I. 120.
- Several Chorographical Problems useful in *Surveying*, I. 120.
- A growing Error of *Surveys* taken with the Magnetical Needle, I. 125.
- [*Suffex*, Of the Site of some Roman Towns there, IV. 86.]
- Swallows* found in Lakes in Winter, II. 853.
- [*Swan's Neck*, a new Star there, I. 231.]
- An Instrument to preserve the exact Symmetry in drawing Faces, I. 598.

T

- Tadmor*; An account of it, with many Inscriptions, III. 503, to 518. Remarks upon the Antiquities found at *Tadmor*, with many Inscriptions, III. 510, to 526.
- Tadpoles*, the Production of them, II. 818.
- Tangents*, to Geometrical Curves, I. 18.. 116.
- [A method of *Tangents*, I. 13.]
- Tarantula*; an account of a Person supposed to be stung by it, III. 285, 286.
- Tartar*; the Salt of it Volatiliz'd, III. 320. to 325.
- The *Tartarian Lamb* described, II. 646.
- Taste*; the Organ of it, III. 58.
- [Observations on the Clais of sweet *Tastes*, II. 207.]
- A new Star in *Taurus*, I. 263.
- New *Teeth* in two aged Persons, II. 297..
- [Large *Teeth* dug up in *Northumberland*, IV. 102. in *Ireland*, with Remarks, 104.. in *New-England*, III.]
- Telescope*; why a *Telescope* with four Convex Glasses Erects the Objects, I. 189..
- The Apertures of *Telescopes*, I. 191.
- To measure Distances with a *Telescope* at one Station, I. 192.

Excel.

A General INDEX of Matters.

- Excellent *Telescopes* of several Inventions, I. 193.
 A new *Catadioptrick Telescope*, I. 197.
Apertures and Charges of Reflecting Telescopes, I. 200.
 Plain Sights prefer'd to *Telescopic*, I. 221.
 [*Telescopes*; How *Myopes* may use them, without Eye Glasses, I. [252.] Who the Inventor of *Telescopic* Sights, I. 252.]
 The *Temperature* of the Air in America, and its gradual Alteration, II. 42.
 [*Temple* of the Pagans at *Cannara* in *Salsette*, IV. 101.]
 The great *Tendon* above the Heel, after an entire Division of it, sitch'd and cur'd, III. 298, 299.
 [A Journey to the Pike of *Teneriff*, IV. 147.]
 The *Testes* examin'd, III. 121. The Texture of them explain'd, III. 192, to 194.
 The *Testudo Veliformis Quadrabilis*, I. 22.
Thebes; the Latitude of it, I. 564.
Thermometers; Observations made with them, II. 32, 33. A *Thermometer* observ'd at Sea, II. 33. Divisions of the *Thermometer* ascertain'd by several Fluids, II. 33 to 36.
 [A new *Thermometer*, III. 10.]
 [*Thighb*, a Tumor and Fracture in it, II. 251.]
Thorax; a great quantity of Liquor found in it, III. 76, 77. A Dropsy in it, III. 77. Warm Water injected into the *Thorax* of a Bitch, III. 78.
Ductus Thoracicus; a Communication of it with the Emulgent Veins, III. 258. A Communication of it and the inferior *Vena Cava*, III. 259, 260. Annotations on this Discovery, III. 261, 262.
 [*Thoresby*, (Mr.) several Rarities in his *Museum*, IV. 229.]
Thunder and Lightning; the Direction of Ship-Compasses by them, II. 280.
Thunder and Lightning, the Causes of them consider'd, II. 182, 183, 184.
Thunder; Accidents by *Thunder* and Lightning at Oxford, II. 169, to 172. In Hampshire, II. 172. At Stralsund in Pomerania, II. 172, 173. At Dantzick, II. 174. at Portsmouth, *ibid.* At Oundle, II. 175. On board the Suffolk in the Bay of Biscay; *ibid.* near Aberdeen in Scotland, *ibid.* At Smyrna, II. 176. In Northamptonshire, II. 177, 178. In Yorkshire, An. 1698, and 1700, II. 179.
Tides; Directions for observing them, II. 260, 261. *Tides* observed at London, II. 261, 262. and at Dublin, 263, 264. Nigh Plymouth, II. 264, 265. In Hong-Road, four Miles from Bristol, II. 265, to 267. At Chepstow, II. 267. In France, II. 267, 268. At Bermudas, II. 268. Annual *Tides* in several Places in England; the variety of them consider'd, II. 278, 279. Dr. Newton's Theory of *Tides*, explain'd by Mr Halley II. 285 to 288. *Tides* extraordinary about the Orkneys, II. 290. And in the West Isles of Scotland, II. 291. At Tunqueen, II. 292, to 295. A Theory of the *Tides* at Tunqueen, II. 295, 296.
Timber; the best Season for felling it for Ships, I. 589. The Difference of *Timber* in several Countries, and sell'd at different Seasons, I. 592.
Time; to find the apparent *Time* at Sea, I. 552.
Tin Mines in Devon and Cornwall, II. 565. How the *Tin-Diggers* train a Load, II. 566, 567. How they dig the Ore, II. 567, to 569. How they dress the *Tin*, II. 569, 570. Blowing of *Tin*, II. 571. Where to find the Stone from which *Tin* is wrought, II. 572, 573.
 [*Tobacco*, the Culture of it in Ceylan, III. 299.]
Tortoise; Observations on it, II. 825. One that lived 3 Days without a Head, II. 826.
 [The Heart of an American Land *Tortoise*, Anatomically describ'd, III. 349.]
Townley in Lancashire; the Longitude and Latitude of it, I. 560.
Trade-Winds; the Cause of them, II. 129.
Tredagh in Ireland; the Latitude of it, I. 560.
Trees; the Communication of the Parts of it with the Parts of the Fruit, II. 710, to 712.
 [*Trees* found under Ground, III. 263. & seqq.]
Trigonometry, I. 120. Conick Sections applied to *Trigonometry*, I. 62.

A General INDEX of Matters.

Trochita and *Entrochi* describ'd, II. 493, to 503.

Tropical Signs; To find the Sun's Ingress into them, I. 266.

Truffles describ'd, II. 624, 625.

Trumpet; the speaking *Trumpet*, I. 505. Defects of the *Trumpet* and *Trumpet* Marine, I. 607.

[Ancient *Trumpets* found in Ireland, IV. 100.]

Turkey; Observations in it, III. 605.

[*Turneps*. Of their great and speedy Vegetation, III. 297.]

U

Under Currents, in the Downs, at the Streights Mouth, and in the Baltick; II. 288, 289.

Upper-Egypt, Observations upon it, III. 527, 528.

Uraniburg; the Longitude of it, I. 563

Ureters; four of them found in an Infant, III. 146.

Urine; a Passage of it to the Bladder, distinct from the *Ureters*, III. 147. Suppressions of it (not caus'd by Stone) Cured by Acids, III. 148.

[*Urine*; A new passage for the drink and *Urine*, II. 77. A Boy that never made water, 96. Another who made water by his Navel, *ibid.*]

[*Urns* found in Norfolk, IV. 97. in Ireland, 98.]

Uterus; the Structure of it describ'd, III. 197, to 205.

V

[*Vacuum*; Of the motion of *Pendula* in *vacuo*, III. 198. Experiments to prove an interspers'd *Vacuum*, *ibid.* 200.]

An Error in Surveys taken with Magnetic Needles from their *Variation*, I. 125.

To find the *Variation* of the Comps at Sea, I. 584, 585.

To make China *Varnishes*, I. 602.

Vasa Testicularia of a Beetle, II. 782.

Vegetable Excretencies; Observations about them, and the Insects bred in them, II. 763.

[Of the motion of the Sap in *Vegetables*, III. 291.]

Vegetation; Observations concerning it, II. 712, 713. Thoughts and Experiments about it, II. 713, to 718. Reflections upon these Experiments, II. 718, to 728.

Vegetation; and the Running of the Sap; Experiments and Observations about them, II. 673, to 689.

[Observations concerning *Vegetation*, III. 290.]

Veins in Plants observed, II. 691, to 696.

Veins of a Dog; Liquors injected into them, and the Effects, III. 232. Mercury injected into the *Veins* of Dogs, III. 233. Medicated Liquors and Medicines, injected into human *Veins*, III. 234.

The Arterious *Vein*, wanting in some Animals that have Lungs, III. 256.

[*Veins* and Arteries, Schemes of them, II. 124. Of the motion of the Blood in them, I. 418.]

[*Veneral Disease*; Its Antiquity, IV. 245.]

Venus; a Transit of the Moon above *Venus*, An. 1670, I. 347. Spots in *Venus*, I. 425. The Rotation of *Venus*, *ibid.* An Observation of *Venus*, I. 426. The visible Conjunctions of *Venus* with the Sun, I. 427.

[*Venus*; Of its Appearance in the Day-time, I. 324. Observations of it, 360, 365. Two Conjunctions with Jupiter, 362, 363.]

Versailles; the Aquæduct there, I. 594.

[*Vesuvius*. Eruptions of it, III. 232.]

[*Vetter*, A Lake in Sweden, III. 225.]

The Synchronism of *Vibrations* in a Cycloide, I. 462.

Vines; a new Way of cultivating them, II. 656.

Vinegar; the Way of making it in France, II. 657, 658.

A new tuning of the *Lyra-Viol*, I. 618.

Vipers and Snakes, the Way of breeding them, II. 711. Experiments made with *Vipers*, II. 811, to 813.

Virginia; the Advantage of it for building Ships, III. 560. An Account of it, III. 566, to 576. A Voyage to it, and a further Account of it, II. 575, to 600.

Vision; a Duplicity of it, and a *Gusta*
Y y y y *Serena*

A General INDEX of Matters.

Serena after great Pains in the Head and Convulsive Fits, II. 40.

Vitriol, the Oyl of it encreasing in Weight, II. 534, to 537. White *Vitriol*, II. 537, 538. Experiments about *Vitriol*, Sulphur and Allum, II. 541, to 548.

Vitriolate Water; some Effects of it, II. 328.

A *Viviparous Fly*, II. 787.

A *Voyage* from Venice to Smyrna, III. 451, to 456. From England to Constantinople, with Observations made in them, III. 456, to 465. A *Voyage* of some English Merchants at Aleppo to Tadmore, III. 489, to 492. A second *Voyage* to Tadmore, III. 492, to 503.

A *Voyage* from England to the Caribbee Islands, with Observations upon it, III. 546, to 557. The Observations continued, and some of them consider'd, III. 559.

W

[*Wales*, Observables in a Journey thro' it, IV. 138.]

[*Walnut-tree*, a new kind, III. 303.]

Exact portable *Watches*, I. 465.

Longitude by *Pendulum-Watches*, I. 545.

Water, four Men living on it without Food 24 Days, III. 110.

Water; An Experiment of the Evaporation of it, with an estimate of the Quantity of *Water* arising by Vapour out of the Sea, II. 108, to 110. The Evaporation of *Water* in a Clole Room at Gresham-College, and the different Quantities of it arising in the several Months of the Year, II. 110, to 113.

Optick Lens's of *Water*, I. 195.

Water Microscopes, I. 209.

The Refractive Power of *Water* compar'd with that of Air, I. 230.

The Weight of *Water* in *Water*, I. 520.

The Pressure of *Water* in great Depths, I. 521.

Considerations concerning Raising of *Water* to any Height, I. 537.

A new way of Raising *Water*, applied to several Uses, and Objections answer'd, I. 539.

Water, raised by the help of Fire, I. 544.

[*Water*, its weight under different Circumstances, I. 402. The weight of Bodies

in it, *ibid.* Different densities of it, 404. of its spontaneous ascent, *ibid.* III. 119. & *seqq.* of the Motion of running Waters, I. 409. of the freezing of Water, III. 196.]

Watry Vapours; the Circulation of them, II. 126, to 129.

Wax Work, I. 603.

Weather; Observations upon it in Ireland, II. 43.

Weather; the History of it at Oxford in 1684, II. to 46, to 53. At Cape Corfe, An. 1686, and 1687, II. 53, to 60. At Upminster in Essex, An. 1697, II. 61, to 73. An. 1698, II. 73, to 86. At Emuy in China, An. 1698, 1699, II. 86, to 90. At Upminster, An. 1699, II. 90, to 102.

[*Weather* at Oates, III. 33. at Upminster, 49. in a Voyage to China, 63. at Chusan, 71.]

An Engine to *Weave* Linnen-Cloth I. 501. Tycho Brahe's Observatory in the Island *Ween*, I. 216.

A Map of *Weigats* and Nova Zembla, I. 570.

The *Weight* of several Bodies, I. 522.

The Comparative *Weight* of several Bodies, I. 523.

The different *Weight* of several Fluids in Winter and Summer, I. 526.

A strange *Well*, and some Antiquities found in Kirby-shore, III. 430, to 433.

Wells of fresh Water near the Sea at Bermudas, II. 298. How to examine the Freshness of it, II. 298, to 304. An Ebbing *Well* in Westphalia, II. 305. Another near Torbay, *ibid.* A *Well* taking Fire at a Candle, II. 382.

[*Wen* cut off the Cheek, II. 17.]

West-Barbary; Observations in it from Cape Sparte, to Cape Geer, III. 626, to 631.

The *West-Indian* Way of dressing Buck and Doe-Skins, III. 661.

Whales, and *Whale-Fishing*, about Bermudas, II. 842, to 845.

High *Wheels*; the Advantages of them experimented, I. 503.

Whelp; an Animal resembling it, voided *per Anum*, by a Male Greyhound, II. 904.

The Contrivance of *Whispering* places, I. 309.

A General INDEX of Matters.

- The *Wild-goose* describ'd, II. 849.
Winds; the Cause of them, and the Influence they have upon the Weather in most Parts of the World, II. 129, to 141.
Wind produc'd by the Fall of Water, I. 498.
Wind-pipe and Lungs of Animals; Grafts found in them, II. 869.
Wood found under Ground in Lincolnshire, II. 423. Fossile *Wood* near York, II. 423, 424. In Craven, II. 424, 425.
Wood found in Stone, II. 425.
The *Wood Cracker* described, II. 853.
[*Woodpecker*; Its Tongue describ'd. III. 357.]
Wologda in Russia, the Latitude of it, I. 564.
[*World*. Of its Age, III. 208.]
Worms; a Remedy for them in Children, III. 133. A Worm voided by Urine, III. 135.
Worms found in several parts of the Body; an account of them, III. 137, 138.
The long *Worm* in the Flesh in the East-Indies, III. 138.
Worms, a kind of them eating out Stones, II. 787. Others eating out Mortar, II. 788.
Wostak in Russia; the Latitude of it, I. 564.
[One that could neither *Write* nor read, yet could cast up Sums to great Exactness, IV. 215]
Wroxeter, Some account of it, IV. 68.

Y

Yerflaw in Russia; the Latitude of it, I. 564.

Z

A Description of Nova *Zembla* and *Weigats*, I. 370.
Zirchnitzer-Sea in Carniola describ'd, II. 306, to 317.

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ster. p. 254.

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sects. p. 2218.

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Hotton. p. 365.

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Araneis; *Alter de Cochleis tum Terrestribus, tum Fluvialibus*; *Tertius de Co-* p. 922.
chleis Marinis. *Quibus adjectus est Quartus, de Lapidibus ejusdem Insulæ, ad*
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